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THE ILLUMINATING ENGINEER

LIGHT LAMPS FITTINGS AND ILLUMINATION

THE JOURNAL OF GOOD LIGHTING

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Progress in Decorative Electrical Illumination

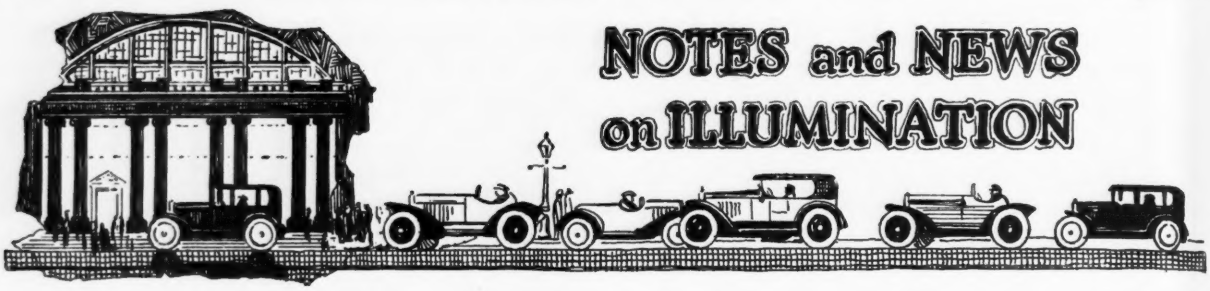
"WHEN the illuminating engineering profession was just learning to toddle the fixture manufacturer's art was an old one." These words served as an introduction to a recent note in *Lighting*, commenting on the gap between the conceptions of the fixture designer and the illuminating engineer—the long-standing difference between those who judge primarily from appearance and those who are chiefly concerned with practical results. These comments referred to the position in the United States, where co-operation between the Illuminating Engineering Society and the Artistic Lighting Equipment Association has only partially resulted in a better understanding. In Europe also we find the same conflict of ideals.

In his instructive paper on "Progress in Decorative Illumination," read before the Illuminating Engineering Society in London, on April 26th, Mr. E. H. Penwarden surveyed the problem from a somewhat wider outlook. He also took into consideration the view of the architect, who is coming to interest himself more and more in decorative lighting, and whose outlook differs in some respects from that taken by the fixture designer. In the main the paper consisted of a survey of the trend of development in lighting fittings during the past eighteen years—Mr. F. W. Thorpe's excellent paper of 1915 serving as a good starting-point. The very fact that methods and materials are now so varied and are changing so rapidly is favourable to co-operation between the architect, the fixture designer and the illuminating engineer; for all are conscious that they are entering imperfectly explored country and are the more willing to pay heed to the ideas of fellow-explorers. Perhaps the outlook of the pure "technician" in lighting matters has been most affected. "Charm" and "effect" obviously play a much more important rôle in architectural lighting than efficiency, in a narrow sense. The technical expert with an obsession in regard to avoidance of loss of light is already obliged to revise his ideas. In an age of abundant light we can afford to lose more than a little, especially when the ultimate aim is a successful *effect*, and the cost of producing it of minor importance.

Nevertheless, the illuminating engineer is on sure ground, even in dealing with the most novel and fanciful light-effects, in insisting on sound methods of design such as minimize risk and ensure permanence, and his instinct for a numerical expression of lighting conditions is still a sound one. Those who recall the chaotic impressions of lighting that prevailed before illumination - photometers became familiar tools are not likely to underestimate the advantage of being able to record results in terms of foot-candles. Without this aid it would be immeasurably more difficult to foresee and contrive successful results in the case of a highly novel lighting installation; or, a good result once secured, to repeat it elsewhere in somewhat different circumstances.

Where a mistake is still sometimes made is in assuming the practicability of intricate calculations and accurate predictions of illumination in the case of lighting schemes of a decorative character. (The singular variation in estimates of the illumination in the Trocadero Restaurant, at the annual dinner of the Illuminating Engineering Society last year, was an illustration of how one can be misled, even in the case of a comparatively simple installation; it was instructive also to observe that those who attempted to calculate fared far worse than those who based their estimate on purely visual observations of the general effect!) Architects and fixture designers alike recoil from attempting involved mathematical calculations in such cases as these. Most experienced designers of original decorative lighting schemes would endorse Mr. Penwarden's courageous assertion that the prediction of illumination in such cases is in the nature of "an enlightened guess" based on the instinctive recollection of past observations and measurements.

Modern decorative lighting, involving as it does the use of the entire architectural make-up of an interior as a medium for lighting effects, is a much more complex process than the "artistic lighting" of the past, which centred almost exclusively round the design of the chandelier. Under the new conditions lighting experts, fixture designers and architects are all involved. Much is heard of the need for co-operation between these specialists. Is it possible to define more precisely what we mean by this term? Certain obvious measures—such as the allocation of positions to lighting apparatus in the early stages of building design—are clearly desirable, but co-operation really goes beyond this. It implies a mutual understanding of method and a sharing of ideals such as are keenly felt by the artist and craftsman but are difficult to define in words. One may pave the way for such an understanding in the lecture theatre, but it can only be completely attained by sharing in a common effort.



The Illuminating Engineering Society

FORTHCOMING MEETING.

The next meeting of the Illuminating Engineering Society, which is to take place at the E.L.M.A. Lighting Service Bureau (15, Savoy Street, Strand, London, W.C.), at 6-30 p.m., on May 24th, will be a joint gathering with the Association of Public Lighting Engineers. A paper survey describing the work of a public lighting department is to be presented by Mr. E. Marrison, who is associated with the street-lighting department of Sheffield. Members of the A.P.L.E. are naturally more familiar with this subject than members of the I.E.S., to many of whom this account will constitute new ground. We think, nevertheless, that there is sure to be plenty of material of general interest, and it is hoped that there will be a good attendance of members of both bodies.

Public Lighting and Street Safety

A feature of the Annual Congress of the National Safety First Association, which is being held in London during May 4th to 7th, is a variety of subjects covered in simultaneous sessions. The Minister of Transport is presiding at the opening joint session, when Sir Henry Piggott is to discuss the Road Traffic Act (1930) in relation to public safety. Provision is made in the programme for a Women's Session on "Accidents in the Home," for the discussion of Industrial Safety, and for a joint session with the Air Ministry, when "Air Sense" and "Aerodrome Construction and Operation" will be discussed. To readers of this journal the event of chief interest will be the joint session with the Association of Public Lighting Engineers on the morning of Thursday, May 5th. Mr. Harold Davies is to present a paper summarizing the ideas of members on "Public Lighting as a Measure of Safety and an Aid to the Guidance of Traffic," and any members of the Association or the Illuminating Engineering Society who desire to attend will be welcome. The National Safety First Association is, as usual, arranging a long series of "Safety Weeks" in various towns and cities during the present year. When it is recalled that approximately 18,000 persons are killed annually in accidents of all kinds, the need for the movement is evident; we hope that the opportunity will be taken to press home the vital importance of good lighting alike in the street and in the factory.

Royal Sanitary Institute

FORTHCOMING ANNUAL CONGRESS.

The next annual congress of the Royal Sanitary Institute will be held at Brighton during July 9th to 16th, when Lord Leconfield, Lord Lieutenant of Sussex, will preside. Professor C. E. A. Winslow, of Yale University, will lecture on "Current Tendencies in American Public Health." The range of subjects for discussion is a wide one. We notice that "Illumination in Industry" figures on the list. This opportunity of bringing home the importance of good lighting in the interests of health should not be overlooked.

The Illuminating Engineering Society of Australia

According to all accounts, the Illuminating Engineering Society of Australia is making steady progress in spite of the general industrial depression, which has been felt with special acuteness in Australia of late. At a recent meeting it was announced that a special committee of the Society had prepared a decorative lighting scheme in connection with the Electrical and Radio Exhibition held in Sydney. The Council is now occupying itself with the formation of technical committees, and is putting forward a request that the Society be represented on the Technical College Advisory Committee. A recent issue of *The Australasian Engineer* (the official journal) contains a paper delivered before the Society by Mr. J. Van Dyk, reviewing Show-window Lighting.

Precautions in the Use of Screw-Cap Lamp-Holders

A notice issued by the Factory Department of the Home Office draws attention to certain dangers accompanying the use of screw-cap electric lampholders, such as are now becoming much more usual owing to the tendency to use lamps of relatively high candle-power in factories. In the case of such holders the screw is a conductor forming part of the electric circuit, and if this is not completely enclosed shocks are possible. Six fatal accidents due to this cause occurred in 1930. There are several factors conducive to danger. High candle-power lamps are naturally mounted fairly high up. Access may involve the use of ladders, and a worker is thus apt to steady himself by grasping some adjacent structure (possibly of metal and connected to earth) with one hand, whilst with the other he attends to the fitting, and may thus touch the live screw. A shock will then occur and a fall is probable. It should be noted that this danger may persist even when lights are "off," since a wrongly placed switch may quite well break the circuit and extinguish the lamp without cutting off the pressure. (Double-pole switches are greatly preferable in this respect.) The danger may be removed by the addition of an insulating skirt to cover the screw, and leading manufacturers are now in a position to supply holders of this type.

Public Lighting at Nottingham

The recent appointment of Mr. J. Sellars to the office of Public Lighting Superintendent to the City of Manchester has left a vacancy at Nottingham, where Mr. E. Howard, of the Oldham Gas and Water Department, has now been appointed Public Lighting Superintendent. Mr. Howard received his early training in the Oldham Gas Department, with which he has been associated for the past 18 years, passing into the Drawing Department, and finally taking charge of the distribution side of the gas and water undertakings. We understand that Mr. Howard will be attached to the department of the City Gas Engineer.

TECHNICAL SECTION
COMPRISING
Transactions of The Illuminating Engineering Society and Special Articles
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The Application of Electric Light to Agriculture

By F. E. ROWLAND, A.M.I.E.E.

(Paper read at the Meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C.2, at 6-45 p.m., on Friday, March 18th, 1932.)

Introduction.

THE development of electricity supply in rural areas and its consequent accessibility for use on farms is creating a great deal of interest in the various applications of electricity in this field.

For those living in rural areas one of the principal advantages to be derived from a supply of electricity is electric lighting. Before the advent of electricity the only forms of lighting available were of an inefficient nature compared with modern standards, and consisted chiefly of candles and oil lamps, both of which have the drawback of inefficient illumination and the necessity of labour to keep them in efficient operation. Both of these disadvantages are eliminated when electric lighting is used.

In this paper it is proposed to deal with electric lighting for agriculture, and for convenience the subject is dealt with under the two most important headings:

1. Electric lighting for the general farm.
2. Electric lighting for the poultry farm.

A sphere in which the use of electric lighting is creating a great deal of interest at the moment, and which is closely allied to the subject dealt with in this paper, is the use of electric lighting for horticulture, for promoting and controlling the growth of plants. However, this is a highly specialized application and is a subject of its own. A number of papers have appeared on this subject recently, and it is considered that proper consideration would be too lengthy and too specialized to incorporate it in this paper.

Electric Lighting for the General Farm.

Advantages of Electric Lighting.

It may appear unnecessary to refer to the every-day advantages of electric lighting applied to a situation such as a farm, because they are so well known to those accustomed to its benefits, but when discussing a subject of this nature it is frequently useful to consider the particular aspects which apply to the application under consideration, and which appeal to those connected with the industry for which it is required.

Until the advent of electricity the lighting of farm buildings depended on the use of candles and hurricane lamps. These illuminants are of a primitive nature, with considerable fire risk, the production of fumes, and labour is required to keep them in service.

A farm is to all intents and purposes a workshop or factory, and consequently efficient illumination is not only a convenience but a means of expediting work and of saving money.

A properly installed system of electric lighting in farm buildings will enable work to be carried out at night with the same expedition as in the daytime. In the case of old buildings, which are inadequately illuminated by day, electric lighting will frequently be superior to natural lighting. The most striking instance of the advantage of electric lighting in a farm is during early-morning milking in the winter. Instead of groping about with a hurricane lamp in the early hours of the morning, a farmer can walk into his buildings, and at the touch of a switch flood them with light and proceed with his work with the same expedition as in daytime.

Not only is the work carried out more rapidly and efficiently, but the risk of spilling is reduced to a minimum and the working conditions generally made more hygienic.

Illumination of Farm Buildings.

An electric-lighting installation in a farm does not present any unusual problems to the illuminating engineer, and should be dealt with in the same way as any other industrial installation. Care must be exercised to ensure that there is adequate illumination for carrying out various operations with ample light on the working plane. Special attention should be given to avoid shadows being cast by

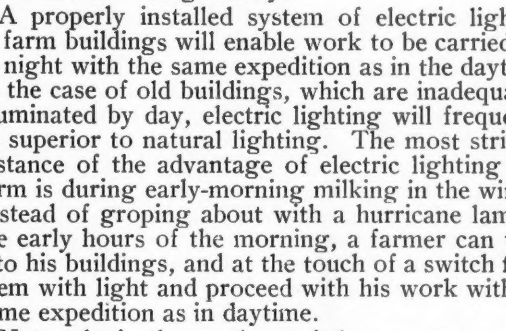


FIG. 1.—Milking Shed by night.

workers walking between the source of light and the work. As an example, one situation where this may occur is in a milking shed if the lighting points are placed low down, with a working alley-way between the lights and the cows.

In a farm where milking is carried out, the milking shed is the principal working space, and its lighting therefore requires careful consideration. The main consideration is to provide uniform distribution of light without shadow on the working plane, which is, of course, a simple illuminating engineering proposition.

The spacing of fittings is frequently controlled by beams, particularly in old buildings, and generally it will be found more satisfactory to suspend the fittings between the beams at such a height as to avoid the beams casting shadows, rather than to mount the fittings direct on the beams.

In the latter case head room is frequently limited, with possible damage to the fittings. In other parts of the farm buildings such as the dairy, stables, barns, etc., the installation should be on similar lines.

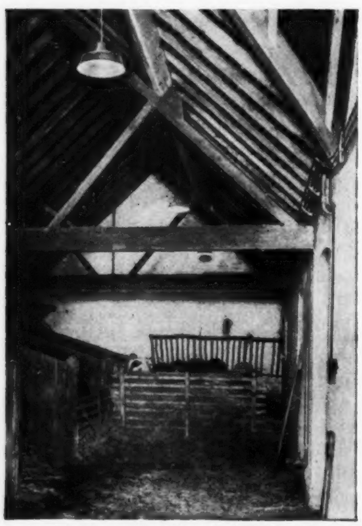


FIG. 2.—Stables with Electric-lighting Pendants between beams.

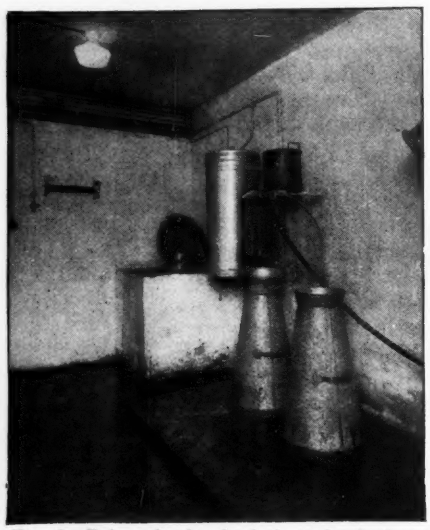


FIG. 3.—Dairy, showing hygienic enclosed glass lighting fitting.

Below is given in tabular form the lighting intensities applicable to a typical farm installation:

	Maximum Foot-candles	Minimum Foot-candles
Milking Shed :—		
Illumination at milking level ...	2.75 ...	1.5
Dairy	3.5 ...	1.5
Food-preparing Room	3.5 ...	0.5
Stables	3.5 ...	1.5

Lighting Fittings.

Equipment for the illumination of farm buildings should be standardized to the greatest possible extent. It is accordingly recommended that B.E.S.A. reflectors should be standardized throughout, except possibly in the case of the dairy, to which reference will be made later.

In most farm buildings 60-watt Pearl lamps will be found adequate, and to facilitate the stocking of spare lamps for replacement it is advantageous to use, if possible, only one size of lamp, or at any rate reduce the number of different sizes to a minimum. A B.E.S.A. reflector provides a high degree of even illumination over the working plane, is easily installed, and with a height-spacing ratio of $1\frac{1}{2}$ to 1 a satisfactory lighting scheme is easily worked out.

In dairies totally enclosed dust-proof lighting fittings with low-absorption glassware should be used, and these comply with the necessary hygienic conditions.

When portables are used an all-insulated hand-lamp is useful, and in this connection reference may be made to hand-lamp transformer sets, which render the use of portables absolutely safe in situations such as milking sheds, dairies, stables, etc., where floors may be damp, with a consequent risk of shock.

Switching.

In planning a farm lighting installation the greatest possible use should be made of multi-way switching. Farm buildings are generally of a rambling nature, with several approaches to many of the spaces, and consequently the full advantages of multi-way switching can be utilized. Apart from always enabling a farmer to illuminate spaces from entrances before he enters and eliminate waste of current by switching off when he leaves by any exit, a well laid-out installation enables him to make his rounds at night, switching on lights ahead of him and switching off as he passes out.

Wiring.

Wiring in farm buildings is best carried out in a C.T.S. insulated system, which will withstand the conditions prevalent in and around buildings, and, being all-insulated, is eminently safe in use.

Bakelite accessories, such as switches, lamp-holders, and plugs and socket, should be used, as they will stand up to the conditions satisfactorily and also have the advantage of being all-insulated.

The use of bakelite detachable type ceiling roses enables pendants to be removed for cleaning or repairs or when white-washing or alterations are being carried out.

Illumination of Farmyards.

Apart from the illumination of farm buildings, the illumination of farmyards is a matter of importance. With electric lighting farmyards can be adequately illuminated so that it is possible to move


FIG. 4.—Farmyard Lighting by B.E.S.A. Reflector.

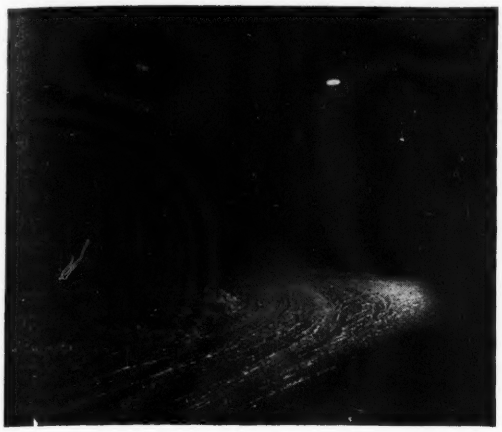


Fig. 5.—Farmyard Lighting, night view.

about after dark with the same facility as during the day, and work can also be performed after dark if necessary. For farmyard lighting B.E.S.A. reflectors similar to those already referred to can be used, either suspended from brackets or centrally suspended.

For temporary work in farmyards or stackyards a portable fitting of the cargo type with a length of C.T.S. cable of 20 to 30 yards will be found a great convenience.

Electric Lighting for the Poultry Farm.

The principal use of electric light on the poultry farm is in the poultry houses for increasing egg-production and accelerating the growth to maturity of table birds.

The use of electric light for these purposes is generally considered a novelty by those unacquainted with the poultry industry, although it is an application which has been used for a considerable time and is well-established in the industry, particularly for increasing the supply of eggs during the winter.

The principal object in using electric light for this purpose is to extend the period of light during short winter days and so increase the birds' opportunity for taking food. Incidentally the exercise they obtain at the same time assists assimilation and digestion.

This artificial treatment is not detrimental to the health of the birds, as is sometimes imagined; in fact, it provides them with conditions more like those to which they are accustomed by nature. The domestic fowl originated in the tropics, where the days are longer than those in the northern latitudes

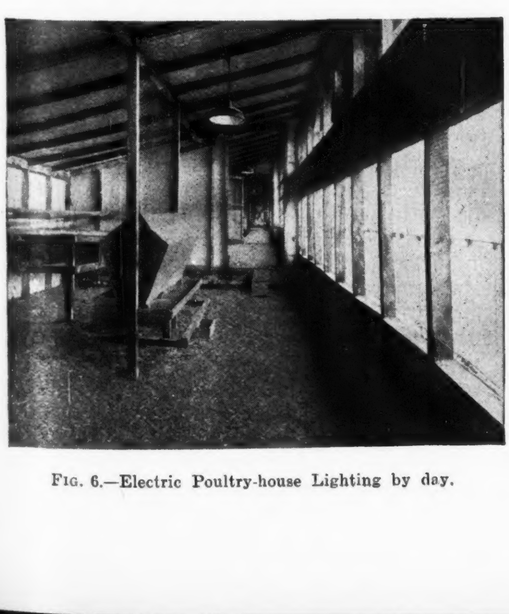


Fig. 6.—Electric Poultry-house Lighting by day.

during the winter, and consequently the use of artificial light produces conditions similar to natural conditions.

Lighting Equipment.

The main considerations which require attention when illuminating poultry houses is to provide even distribution of light of sufficient intensity over the scratching area to enable the birds to feed; also some direct light on the perches, so as to awaken the birds when lighting is switched on in the dark and enable them to return to roost before the lights are switched off after dark. Some authorities do not consider dim lighting necessary when switching on in the dark, but others prefer it.

It has been found by experience that the most suitable lighting medium is a reflector of the B.E.S.A. type used in conjunction with a 40-watt or 60-watt Pearl lamp. From the point of view of economic considerations the intensity of illumination recommended is a maximum of 2 foot-candles beneath the fittings and a minimum of 0.5 foot-candles on the perches. The use of detachable ceiling roses enables pendants to be removed for cleaning and during whitewashing, repairs or alterations.

Systems of Lighting.

Several systems are employed for lighting poultry houses, the principal being:—

1. Morning lighting.
2. Evening lighting.
3. Morning and evening lighting.
4. " Evening lunch " lighting.

Fig. 7.—Electric Poultry-house Lighting by night.

With all systems the principal object is to increase the hours of light to from twelve to fourteen, so as to give the birds a full working day.

Morning lighting provides artificial light for a few hours in the morning, and has the advantage that a simple and cheap form of automatic time switch can be used for turning the lights on some hours before dawn, and they can be switched off by hand after dawn.

One drawback of this system is that it is necessary to put the food out overnight with a consequent encouragement to vermin. This method has achieved a certain amount of popularity in England, and is effective in promoting activity and increasing production, because the birds are hungry when the lights are turned on.

Evening lighting provides artificial illumination at the end of the day and is very convenient, because it does not take place at such an awkward time, as regards labour, as is the case with morning lighting. However, as it comes at

the end of the day the birds have not the advantage of a rest and an opportunity to develop an appetite beforehand, and consequently it is not as stimulating as morning lighting.

Morning and evening lighting is a combination of the foregoing, and is frequently found to be the most convenient and stimulating as regards increased egg-production and the general condition of the birds.

The " Evening lunch " system consists of illumination for a period during the early part of the night, the lights being switched on at 9 p.m. for an hour or two, according to the experience or preference of the poultry farmer. This system has many advocates, and has the advantage of being economical in use of current, because as a rule it is not in operation for so long and also shortens the uninterrupted period of rest between sunset and dawn. However, it is less convenient and requires more expensive regulating equipment than some of the other methods.

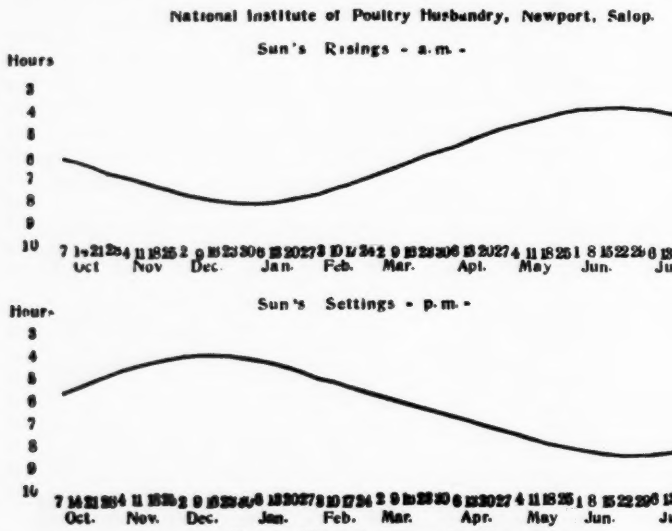


FIG 8.—Time of rising and setting of the sun.

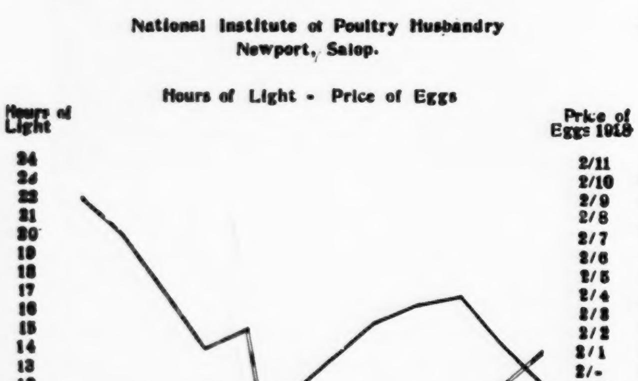


FIG. 9.—The relation of hours of daylight and the price of eggs.

Methods of Control.

There are various methods of controlling poultry-house lighting, one of the main advantages of electric lighting being the ease of control, which can be entirely automatic. This is a very important consideration, because it eliminates the human element and the possibility of irregular operation, which is detrimental to results.

A means for dimming the lights may be required to provide a period of dim lighting lasting from ten to twenty minutes, when the lights are switched on in the dark, such as with morning lighting or " evening lunch," and a similar period is necessary at the end of the operation when the lights are switched off in the dark, as in the case of evening lighting or " evening lunch."

The advocates for dimming when switching on in the dark maintain that it avoids frightening the birds, which might occur if the lights were turned on suddenly, although, as already stated, some authorities do not consider dimming when switching on necessary. A dim period before switching off enables the birds to return to roost and prevents them spending the night on the floor, which is both detrimental to their health and also exposes them to the risk of attack by vermin. It also prevents them taking fright, with a possibility of injury, which might occur if the lights were switched off suddenly.

The methods of control vary from simple manual control by means of an ordinary switch to automatic motor-driven switches with resistances, which simulate sunrise and sunset by gradually increasing the light at the beginning of the lighting period and gradually lowering them at the end.

The methods of dimming most usually adopted fall into four categories:—

1. Fixed resistances.
2. Two-circuit system.
3. Series-parallel wiring.
4. Graduated dimming control.

Automatic or manual control can be used with any of these systems, automatic being recommended, except in the case of very small installations where cost is a primary consideration.

The fixed resistance method employs a resistance which is switched into the circuit during the dim period and short-circuited when full light is required. The chief drawback of this system is that resistances have to be rated according to the load of the lamps installed, and any alteration in the system involving an increase or decrease in the number of lamps may necessitate changing the resistance.

The two-circuit system employs two separate circuits with two leads and a common return. One circuit is equipped with bright lights for full illumination, and the other with 15-watt Pearl lamps in bakelite backplate lampholders for the dim circuit. The bright lights are placed in the usual position over the scratching area and the dim lights over the perches. The advantages of this system are that it is very positive in action and eliminates all complicated control gear, as it is operated by a straightforward change-over switch. Further, the installation can be extended or curtailed without the necessity of adjustment to the dimming control.

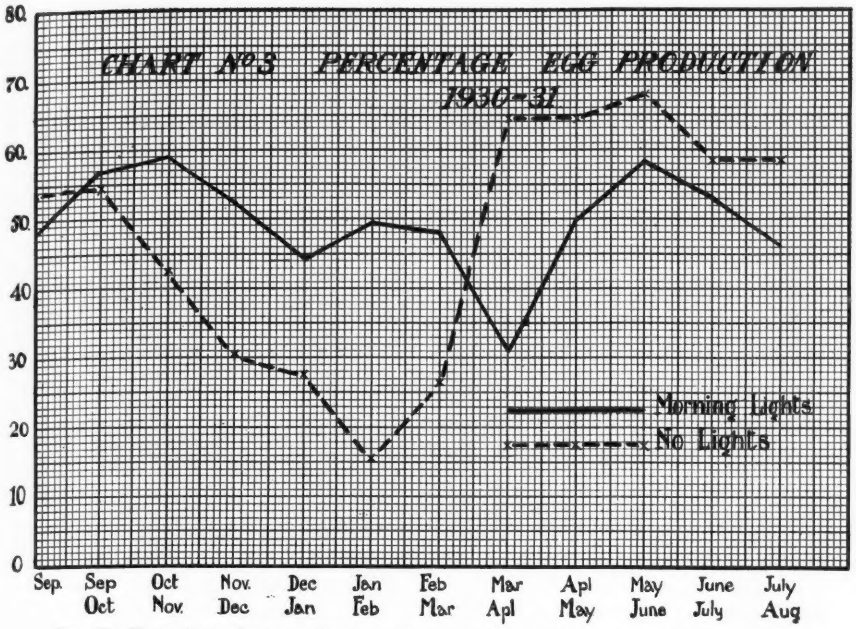


FIG. 10.—Percentage of egg-production with no lighting and morning lighting compared.

Series-parallel wiring employs lighting points wired so that all the lights are in parallel for full lighting and pairs of lights are in series for dim lighting. This method eliminates resistances and complicated control apparatus, but is not so positive in action as the two-circuit system.

Graduated dimming control employs variable dimmers, so that the lights can be raised from zero to "full on" in from ten to twenty minutes at the beginning of the lighting period and lowered during a similar time at the end of the operation.

Many authorities do not consider that graduated dimming is necessary, but some poultry farmers have a preference for this method and insist on using it. With manual control it necessitates an individual standing by to raise and lower the lights with the possibility that the process may not always be regular, particularly if the operator is in a hurry. As regularity of operation is advisable, this is an important consideration.

Automatic control necessitates the use of expensive apparatus, the cost of which is generally prohibitive except in the case of large installations.

Some carefully observed results of electric lighting for egg-production have been made at the National Institute of Poultry Husbandry, and are included below by the courtesy of the Director, Professor R. T. Parkhurst.

A diagram is presented showing the time for the rising and setting of the sun in London. It will be observed that in December the length of day is about eight hours, and in June seventeen hours, and the object of artificial lighting for poultry is to reduce the great difference. (See Fig. 8.)

A supplementary chart shows the variation in the price of eggs at different times of the year, and it will be observed that the prices during the winter are considerably in excess of those ruling in the summer. (Fig. 9.)

The object of artificial lighting is, of course, to increase the production of eggs during the period when prices are high. The latest published results of experiments indicate that morning and evening lighting should be given careful consideration, because in addition to increased production it has advantages in the convenience of operation and absolute regularity, as it is not influenced by the normal change between twilight and dawn. The use of light is so closely linked with good breeding, feeding and housing management that one cannot be separated from the other, and the joint results usually justify the expense and trouble incurred. It is most important to emphasize this point, because the indiscriminate use of lights without proper management and feeding will not necessarily produce increased yield.

The accompanying data show the comparison between morning lights and no lights, from which the increased egg-production with artificial lighting between October and March is apparent, and it will be noticed that the production with lights falls off after March, but by this time prices have dropped, and consequently this decrease is not a material point. (Fig. 10.)

Similarly a comparison between morning lights and morning and evening lights is presented. This clearly demonstrates the increased production with morning and evening lights from October to February, which is the period when prices are highest. (Fig. 11.)

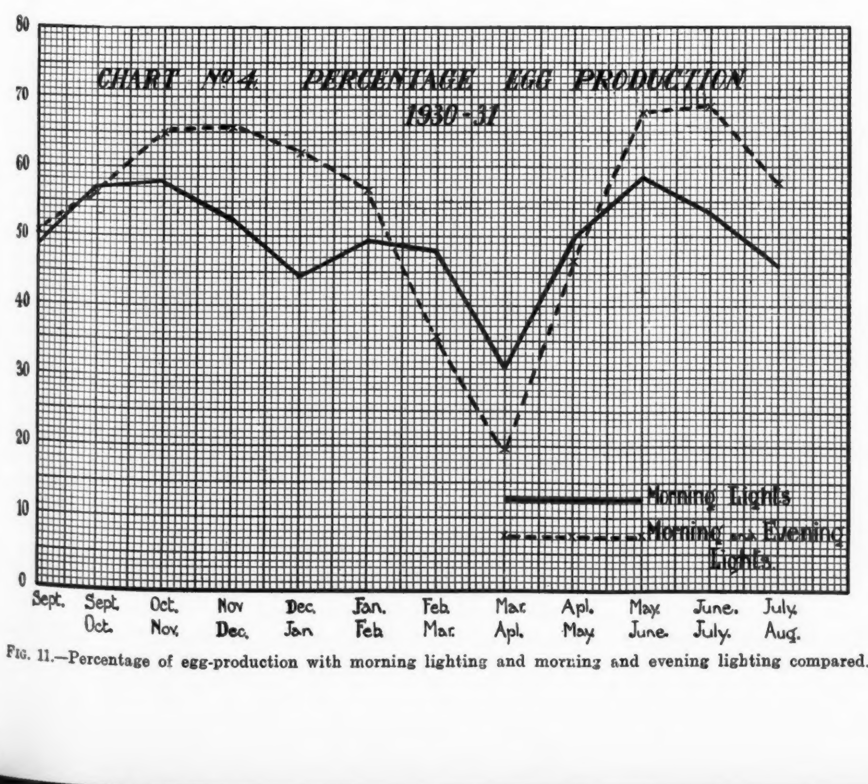


FIG. 11.—Percentage of egg-production with morning lighting and morning and evening lighting compared.

Ultra-violet Irradiation for Poultry.

A paper on Electric Lighting for Poultry would not be complete without some reference to the use of ultra-violet irradiation for improving the health and stimulating the growth of poultry.

A considerable amount of work has been done in this sphere. The principal object aimed at is to provide the birds with artificial sunlight to act as a stimulant and prevent any ill-effects which may be caused by a deficiency in vitamins, and particularly to prevent leg weakness in chicks.

Until now arc lamps or mercury-vapour lamps have chiefly been used. As regards convenience in operation, the mercury-vapour lamp is superior, but has the drawback of being fragile, and in the larger sizes is expensive. In addition, in the larger sizes the irradiation is sufficiently strong to be a possible source of harm to the operator, and therefore lamps of this description are not recommended for use by inexperienced users.

Recently a new type of lamp has come on the market which offers considerable promise for this purpose, as it is very easy to manipulate and perfectly safe to handle.

FIG. 12.--Treatment of Chicks with ultra-violet light.

This lamp consists of a quartz bulb containing a tungsten filament, an arcing gap and a small quantity of mercury. The tungsten filament is used to vaporize the mercury, which in turn produces a mercury-vapour arc between the electrodes of the arcing gap. The light produced by the arc is rich in ultra-violet rays, and infra-red rays are radiated from the incandescent electrodes. The lamp is used in a special reflector to direct the light in the required direction.

One investigator who has used a lamp of this description claims the following results:—

Of four cockerels from the same hatching, two were subjected to ultra-violet irradiation for one hour each day from date of hatching and fed on normal mixtures. The other two were not given ultra-violet treatment, but were fed on food containing a percentage of cod-liver oil. At the end of six weeks the birds receiving the ultra-violet light were almost twice the size of the other two, each weighing 20 ounces, as compared with 11 ounces.

Conclusion.

As indicated at the beginning of this paper, one of the principal advantages of a supply of electricity in rural areas is the provision of electric lighting for use in farming. The applications of electric lighting in this sphere have been dealt with, but the paper would not be complete without brief reference to other uses of electricity which are possible once a supply is available, primarily because all these applications, including lighting, are so closely related.

The lighting load is comparatively so small that without the development of other uses of electricity, rural electrification on an extensive scale would be impracticable. In addition to electric lighting, electric power and heating offer outstanding advantages, not only on the farm but also in the farmhouse or dwelling.

It is no exaggeration to state that the greater use of electricity in the future in agriculture, using this word in its widest sense, will play an important part in placing the industry on a sounder footing than is at present the case. Increased efficiency in work and improved amenities of life should play a decisive part in repopulating the countryside, and thus help to solve a most pressing social problem. In this development electric lighting will play a prominent part, and consequently its proper application to agriculture deserves the serious consideration of illuminating engineers.

DISCUSSION

The Chairman (Mr. J. Eck) in asking Mr. Borlase Matthews to open the discussion, said that Mr. Matthews might justly be regarded as a pioneer of electrical farming in this country.

Mr. R. Borlase Matthews congratulated the author. He wished also to congratulate the Society upon devoting an evening to the consideration of such a subject. There were over 400,000 farms in this country, and if only ten lights were put in each it would mean a sale, he hoped, of 4,000,000 scientific B.E.S.A. reflectors, so that an enormous field was open. Six years ago only about 600 of the 400,000 had a supply of electricity; to-day 4,000 had a supply. It would therefore be seen that the increase was rapidly growing.

Good lighting on a farm meant a saving of a third of the time occupied in feeding cattle. That was a very important fact. Electric lighting in milking byres would save spillage, and the milk saved would more than pay for the cost of lighting a byre. The cow byres shown on the screen that evening were the first in the world to be scientifically illuminated, and thanks were due to Mr. Rowland and others who had taken a great deal of trouble in working out the special design. There was here a new and special "working plane," namely, the cow at udder-level height. That was a most important point. The wires furnishing current to the yard lighting fitting, which had been shown on the screen, were live wires supported on insulators. That method avoided the necessity of having an insulated cable half-way across the road. The system was largely used in Brussels.

The paper referred to the use of electric lighting on the poultry farm. Work had recently been done at the Harper-Adams College, and there were now British experiments and tests to confirm the data, whereas formerly reliance had to be placed mainly on the efforts of other countries. Authoritative statements issued by Harper-Adams as the result of experiments, very definitely and clearly set out the savings and economies effected. It was all very well to talk loosely about saving money and making more profit, but the practical poultry farmer wanted definite data, and it was interesting to know that such data was available.

Sevenpence a unit was a rather high price, but, at say threepence a unit, the cost of lighting would only be twopence per bird per annum, and the increased value of eggs ranged from 1s. 8d. to 2s. There was, therefore, a very handsome return,

particularly on a poultry farm where some 2,000 laying birds were in use. Really such lighting for birds ought to be supported by the Society for the Prevention of Cruelty to Animals—because the poultry farmer who did not use electric light was starving his birds for sixteen hours a day in the winter instead of giving them ten hours' sleep at night. Recently the practice of furnishing birds with lighting throughout the whole of the hours of darkness or "night clubs" had been developed. The old type of carbon incandescent lamp used formerly to be employed, chiefly for its heat-giving powers rather than for its light, the lamps being kept alight day and night during the early part of the brooding season.

Many interesting problems could be solved by correct lighting. For instance, the winter moult of birds could be controlled by discontinuing the use of light, and birds could be thrown into a heavy moult in November or December, so that they would produce readily when eggs were required for spring hatching. Hens could be brought into heavy production in August, September and October (August and September being bad months for production), and, further, pullets could be brought on earlier.

The paper dealt with the biggest industry in the country, in fact, the biggest in any country in the world. It was an industry in which there were tremendous opportunities. He had noticed that when electricity was introduced into a new district on the Continent the very first places to which it was applied were the cow byres. That application took place before the electricity was supplied to private houses. It was recognized on the Continent that it was not merely a luxury, but that there was a profit in it.

Mr. F. C. Raphael also congratulated Mr. Rowland. The paper was an excellent one. What had impressed him most was the simplicity and yet the effectiveness of the methods described. He was sure that that should play an important part in extending the application of electricity to farms. It was apparent that no special equipment was required for ordinary lighting, and, being more or less of a standard character, it should be cheap to install and economical to run.

He did not quite follow the percentages quoted in Figs. 10 and 11. This was not apparently a percentage of maximum production, which seemed to be about 60 per cent. Perhaps Mr. Rowland would state what was the basis of the percentage, i.e., what corresponded to 100 per cent.?

On the last table there were figures per bird for 48 weeks. It would be interesting to know the number of birds from which the average was taken. He would also like to know on what scale the experiments were made.

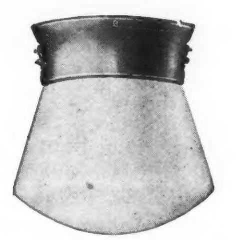
He wished that Mr. Borlase Matthews had told the meeting a little more about "night clubs" for birds. He took it that what was referred to was something different from the "evening lunch" which Mr. Rowland had described. Was it beneficial to have light all night habitually, or was this only for special purposes?

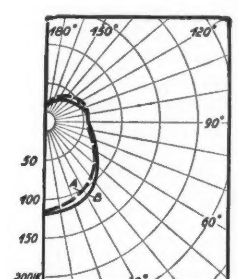
Mr. R. Borlase Matthews remarked that the reference to the "night club" was in connection with an entirely new set of experiments just commencing. Heretofore the data had all been based on results in sub-tropical regions where the birds were brought up. It was now found that with the application of electricity there was a better distribution of eggs (not more per annum) when eggs were scarcest, but the matter had not got to a commercial stage yet. The night club for chicks was a commercial proposition in this country. The birds actually got light during day and night, and it was found that with light up to a certain intensity, when they had sufficient food the birds would sleep for the minimum time that they themselves required instead of the farmer dictating the number of hours of sleep. He merely mentioned the night club to show that finality had not been reached and that further experimental work must be carried out.

Mr. Markham was much interested to hear that what had been described could be safely carried out during the whole of the twenty-four hours. The point was quite new to him. The intensities for cow sheds struck him as rather low. The figure 3 foot-candles was on the low side, especially when current was used for all lighting purposes. The consumption for lighting was small compared with the total amount of current used.

The Chairman (Mr. J. Eck) expressed his interest in the paper, which was rich in information. In the section dealing with poultry farming no mention had been made of ducks. He would like to know whether the same effects had been achieved by the application of light to a duck farm as in the case of a chicken farm. Roughly speaking, there were two classes of ducks—one the "khaki" duck, which was a prolific layer requiring no encouragement and laying, under satisfactory conditions, about 300 eggs per annum. The other class was the Aylesbury duck, which they all knew because of its food value. He believed that the Aylesbury duck laid a far less number of eggs. It would be interesting to know whether, by the application of electric light, the Aylesbury duck could be brought into line with the khaki duck with regard to laying.

They were particularly happy in having definite figures given to them with regard to what could be produced by the aid of artificial light, and Mr. Borlase Matthews had largely confirmed the figures and shown what great things could be achieved on the financial side of electro-farming. He had looked at the percentage curves with wonder and interest, and he agreed with what Mr. Raphael had said about them. It would, he thought, be valuable if the two charts were assimilated into one so that all the conditions could be seen in one view and compared with normal conditions.



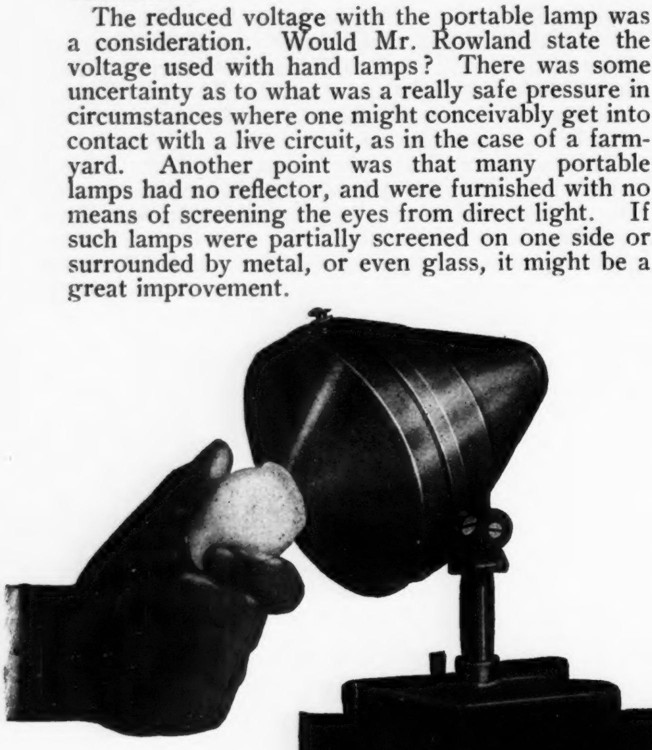


Enclosed Diffusing Fitting with polar curve. (*Mr. J. Eck.*)

As to the fittings that had been shown, it was very satisfactory to realize that the B.E.S.A. reflector could be so widely applied. He noticed, however, that some of the fittings illustrated by the author seemed to have the defect of providing room on the upper part where dust could collect—and probably remain, as it would only slightly affect the emission of light. He had therefore brought with him a lantern slide illustrating a fitting which appeared more suitable for the purpose. This was constructed with a white porcelain base and a glass shade at such an angle that any dust deposited would fall off, provided the surface was dry. The shade consisted of two varieties of glass, the more opalescent one at the sides and the less opalescent variety below, producing the effect with a gasfilled lamp as shown in the polar curve presented. This

glass shade was pressed up against the porcelain base by means of screws attached to a metal collar surrounding the globe and holding it against a rubber gasket, thus rendering it suitable for complete washing. The fitting, moreover, was arranged to accommodate either conduit or cab-tyre sheathed conductors.

The reduced voltage with the portable lamp was a consideration. Would Mr. Rowland state the voltage used with hand lamps? There was some uncertainty as to what was a really safe pressure in circumstances where one might conceivably get into contact with a live circuit, as in the case of a farmyard. Another point was that many portable lamps had no reflector, and were furnished with no means of screening the eyes from direct light. If such lamps were partially screened on one side or surrounded by metal, or even glass, it might be a great improvement.



There was yet another useful application of electric light in poultry farming which seemed to have been overlooked in the paper, namely, the testing of eggs in a rapid and certain manner by the intense projection of light, both through and on the egg, which was held inside the orifice of an opaque container. In the device illustrated the light from a 25-watt lamp was projected by a specially shaped reflector, hemispherical at the back and ellipsoidal in the region adjacent to the orifice, where an intense illumination is concentrated. The completely opaque surrounding fitting was held in contact with the egg by means of a clamp. Observation could be carried out at any time, by day and by night, and the device had proved extremely helpful.

Mr. F. E. Rowland, in reply, thanked the meeting for the interest shown in his paper, and also for the gratifying remarks made upon it.

Dealing with Mr. Borlase Matthews' remarks, he stated that as to a large extent they amplified his own, they hardly called for a reply. He agreed that 7d. per unit was rather a high price for poultry lighting, but stated that this was the cost of current for the experiments he described, the current in this case being generated by a private plant. When current was available from the mains it was generally obtainable at considerably lower rates. The Preston Corporation, which is in the centre of the largest poultry industry in the country, actually supplies current at ½d. per unit for poultry-house lighting, and other undertakings who have developed this load also offer attractive rates.

Mr. Raphael's remarks on the simplicity and effectiveness of the methods described were indeed a compliment. The author believed that Mr. Raphael was specially concerned with trying to keep the industry up to scratch, and consequently his approval was appreciated.

Mr. Rowland agreed that some of the percentages and figures were a little hard to follow, and gave the following explanation: —

The yearly percentage production is calculated on the hen-day basis. Therefore, if a 30-day month and 20 hens are considered, 600 hen-days are obtained. This, divided into 300 eggs laid during the month, gives 50 per cent. production. If hens are sick or die, or have to be removed from the pen for broodiness, the loss in time is subtracted in hen-days; by this means a better comparison of the value of lighting is obtained than would be the case if mortality, sickness and broodiness were not considered. The experiments referred to were actually carried out in six pens, one being a control with no lights and the others being equipped with various types of light. The author did not consider it necessary to give all the results in his paper, and consequently confined his remarks to the results which were of most practical interest. Each pen contained 120 single-comb white leghorn pullets.

One of the tables Mr. Raphael referred to was included in the paper after it was printed, and is now reproduced below: —

SUMMARY OF AVERAGES PER BIRD FOR 48 WEEKS, 1930–31

	No lights	Morning and Evening lights
Income	£0 17 2½	£1 2 1
Food	0 6 2	0 6 8½
Lighting	—	0 0 7¾
Margin over food cost and lighting	0 11 0½	0 14 8¾
Egg yield	154·8	183·4
Percentage yearly production ..	46·07	54·58
Average egg weight, drams ..	31·4	31·2
Percentage first grade eggs ..	50·7	46·8
Total food consumption	70 lbs. 12 oz.	77 lbs. 4 oz.
Average daily food consumption ..	3·37 oz.	3·68 oz.
Average body weight, start ..	3 lbs. 3·9 oz.	3 lbs. 4·2 oz.
Average body weight, end ..	3 lbs. 9·3 oz.	3 lbs. 13·5 oz.
Gain	5·4 oz.	9·3 oz.
Mortality per pen	9	9

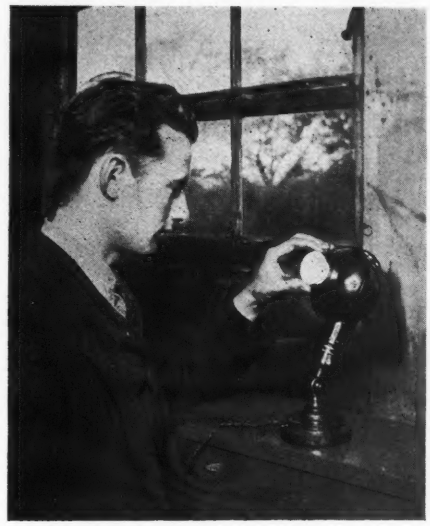
Mr. Markham had commented on the figure of 3 foot-candles being on the low side for a situation such as a cowshed. The author stated that this figure was obtained by taking readings in a shed which was adequately lighted for practical purposes, but added that there would be no objection to increasing this lighting, in fact it would probably prove advantageous. In the installation referred to a satisfactory compromise had been made between efficiency and economy.

Dealing with the Chairman's remarks, the author stated that he had not dealt with ducks because up to the present intensive egg-production had not been developed on a commercial scale. The possibility of increasing egg-production from ducks was worth investigation, and it was hoped that experiments would be conducted shortly. Such experiments would of course be most promising with Aylesbury ducks. A small light is sometimes used all night with ducks to prevent them being disturbed, which sometimes occurs when the moon is full, and also by passing motor-cars.

Mr. Rowland stated that the hand lamp transformer equipment was designed for a secondary output at 25 volts. In addition, it could be used with all-insulated hand lamps with bakelite handles and rubber-sheathed guards, which makes the possibility of shock very remote. He did not think a reflector was necessary, partly because it would be troublesome to make one of an all-insulated pattern which would be unbreakable, also because pearl lamps were used, which prevented glare.

Dealing with the Chairman's remarks on totally enclosed glass ceiling fittings and egg-testing lamps, Mr. Rowland explained that in his paper he only intended to discuss the type of fittings he recommended and not enter into a discussion on the relative merits of particular designs. The totally enclosed glass fitting he had referred to was of British manufacture, and in practice was not found to harbour dust and produced a polar curve of a very similar type to that shown by the Chairman.

In conclusion, Mr. Rowland referred to an egg-testing lamp not included in the printed version of his paper, and showed a slide which is reproduced here. He explained that this lamp, which was of British manufacture, incorporated a parabolic reflector to concentrate the light on the testing aperture and had the advantage that it would accommodate a 40-watt or 60-watt pearl lamp. It was also adjustable in any direction, and special provision was made for clipping it to packing cases when used in egg-testing stations. This lamp is included in the Ministry of Agriculture lists of approved egg-testing appliances.



The Egg-testing Lamp in Operation (Mr. Rowland).

The Experimental Use of Artificial Light in connection with the Growing of Cucumbers in Denmark*

By E. STROUD

MR. ROWLAND has not dealt with the use of artificial light for horticultural purposes, so that it may be of interest if I give an experience in connection with the introduction of artificial lighting in greenhouses in Denmark, with the intention of accelerating the growth of cucumbers.

Mr. Paludan, Lecturer at the Agricultural High School in Copenhagen, was the prime mover in the work, and Mr. Ewertz, of Copenhagen, supervised the experiments as consulting engineer with Mr. E. Benzon, to whom I am indebted for this information and photographs.

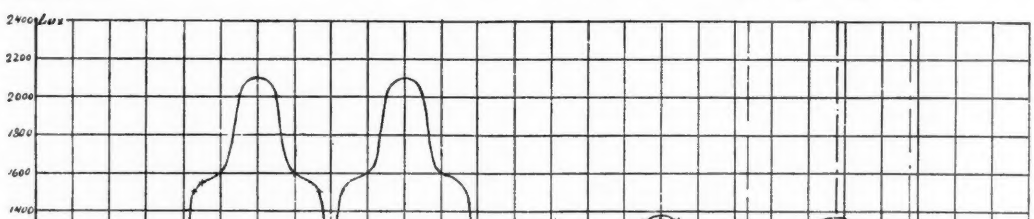


FIG. 1.—Showing distribution of illumination over plant areas.

On the ground of economy the introduction of intensities comparable to those of daylight was out of the question, but is in fact unnecessary as the assimilation of carbonic acid commences at much lower intensities. This assimilation of carbonic acid is the most important of the life functions of the plant, and results in the conversion of this into the carbon compounds of which the plant consists. With increasing intensities of light the assimilation increases quickly to a certain value, which is not exceeded even if the illumination is further increased.

The experiments were conducted in a greenhouse 25 metres long (80 ft.), with a central bench 1.8 metres (6 ft.) wide. A central bench only was used in order to obtain an even illumination, a condition of the greatest importance. It was decided that the distance between the light and the plants should not be less than 1 metre (3 ft. 3 ins.) as otherwise the heat from the lamps might have an injurious effect on the plants.

Five test fields were arranged and were as follows:—

No. 1 was 2.19 × 1.8 metres (7 ft. × 6 ft.) in size, illuminated by a 500-watt lamp in an intensive prismatic glass reflector.

No. 2 was similar and adjacent to No. 1.

No. 3 was a test field without artificial light.

* Presented at the meeting of the Illuminating Engineering Society, held on March 18th, 1932.

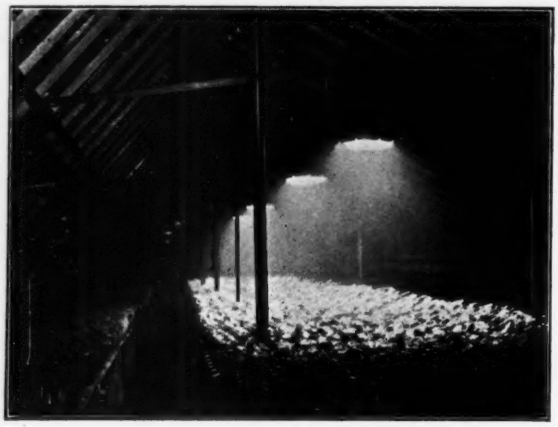


FIG. 2.—A photograph taken on January 17th. Note the concentration of light on plants.

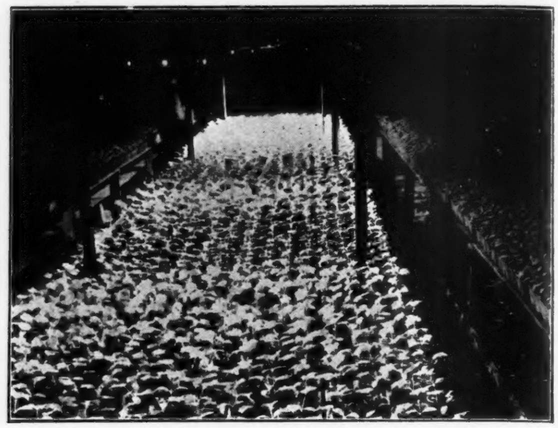


FIG. 3.—A photograph also taken on January 17th, showing tendency of leaves to turn towards the light.

No. 4 was 2.0 × 1.8 metres (6 ft. 6 ins. × 6 ft.) in size illuminated by a 750-watt lamp in a similar reflector to Nos. 1 and 2, and

No. 5 was similar to No. 4.

We have, therefore, five test fields in a line occupying a space about 35 ft. long by 6 ft. wide; two at one end using 500-watt lamps in intensive prismatic reflectors, two at the other end using 750-watt lamps in similar prismatic reflectors, and a centre space without artificial light. The reflectors were covered so that all the light was emitted in a zone of 55°. The height of the units above the new plants was 1.325 metres (4 ft. 4 ins.), and the position of the lamp in the reflector was such that very little light was emitted outside the test fields.

As the object of the experiments was to determine the most economical intensity of illumination, careful measurements were taken on a plane 60 mm. above the bench whilst one unit was lit. The distribution curves illustrated in Fig. 1 were thus obtained. The illumination is, of course, higher between the two lamps than at the sides, but the calculations indicate that 66.5 per cent. of the total light was directed on to the test fields. (In one respect the above calculations do not give an exact idea of the conditions of illumination throughout the season. It must be remembered that the plants grow very quickly and that ultimately the leaves will shade one another. Furthermore, the plants nearest the lamps tend to grow most quickly.)

A brief summary of the method adopted in Denmark in cultivating the cucumber may be of interest. The seeds are sown in flat boxes 60-70 mm. high. A few days afterwards the plants start sprouting and they grow quickly. When the growth of the plant-leaves start, they are planted in pots, a plant in each pot and placed on the bench as close as possible. When the plants have got two to three leaves beside the seed lobes they are planted in still bigger pots. When the height of the plants reach about 300 mm. (12 ins.) they are taken out of the pots and planted in another greenhouse. Here they grow on espaliers and each plant will give 50-80 fruits during the spring and the summer.

The plants used in these experiments were sown on December 29th. Illumination was commenced on January 4th and was applied from 7 p.m. to 7 a.m. in the morning. The plants were placed in pots on January 5th and transferred to larger pots on January 25th.

As the plants grew rather quickly, the reflectors were lifted to the height of 1.65 metres (5 ft. 4 ins.).

Fig. 2 shows a photograph taken on the night of January 17th—note how completely the light was concentrated on the test field.

Fig. 3 shows a photograph taken on January 17th. The two 500-watt test fields are seen in the foreground and 750-watts area in the background. Note how the leaves are turned towards the light. This is evident from the visible "dark belts" between the 500-watt fields, the leaves of plants in this section being turned towards the lamp further away from the photographer.

The photograph shown in Fig. 4 was taken on February 9th. In the foreground are seen some

FIG. 4.—A photograph taken on February 9th. The plants in the foreground which have not been exposed to light are much smaller than those in the background.

FIG. 5.—A photograph taken on January 17th. The influence of light is already evident. The plants on the right and in the centre were taken from the area lighted by 750-watt lamps and 500-watt lamps respectively; the plant on the left from an area receiving no artificial light.

FIG. 6.—A photograph taken on February 9th. The difference in growth is now even more marked.

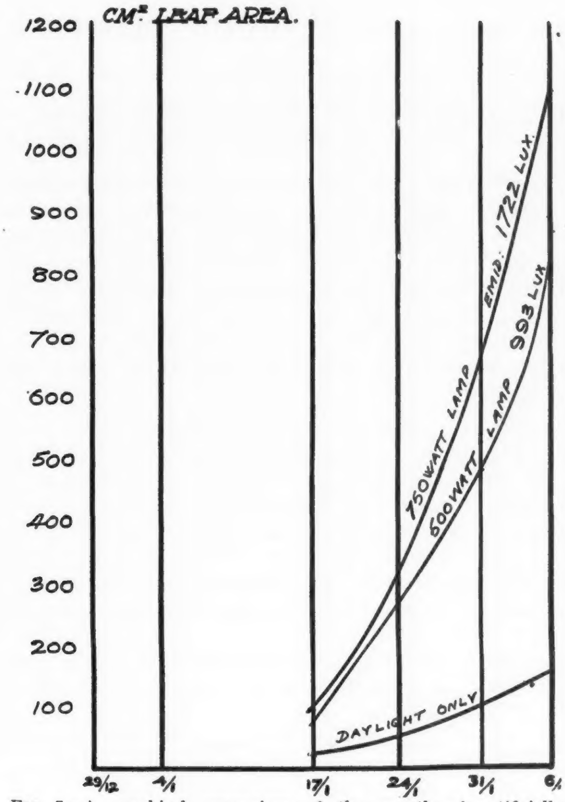


FIG. 7.—A graphical comparison of the growth of artificially illuminated and untreated plants.

plants which have not received any light. Although the presence of the sticks masks the effect to some extent it can be seen that these plants are dwarfs compared with those which have been exposed to the light.

It was impossible to get a photograph of the test fields taken from the side, though the view from this aspect was very interesting, in that the height of the plants followed a curve, which had substantially the same shape as the distribution curve from the reflectors!

From the photographs Figs. 5 and 6, which were taken on January 17th and February 9th respectively, one can get a clear impression of the influence of the light on the plants. The small plants were taken from the field without artificial light, the plant in the middle from the 500-watt field, and the big plant from the 750-watt field.

The results are shown graphically in Fig. 7.

The type of cucumber grown was known as "Butcher's Disease-Resisting." Owing to the influence of the light, the plants showed no disease whatever, which was considered a good result. It was soon evident not only that the light did not have any predjudicial effect on the plants, but that those illuminated had greener leaves and a greater leaf area. This, in conjunction with the longer (artificial) day, creates greater assimilation, and thus contributes to a more robust development of the root. The illumination therefore furnished what was desired, namely a plant in quick and continuous development, which does not stagnate, and is more capable of resistance against diseases. A natural consequence is that it becomes no longer necessary to plant more seeds than precisely those required to furnish the quota of plants, which means a saving in seeds, space and attention.

The record of results shown in the accompanying table is of interest.

The effect of illumination by artificial light during March is very striking indeed. The harvesting of fruits began on March 18th and during the ensuing portion of the month the results were remarkably good. It may be noted that the plants which had been exposed to artificial light maintained throughout the lead they had originally gained. Even during April, when illumination by artificial means is relatively less valuable, the best results were obtained from the artificially illuminated plants. The chief feature, however, is the fact of plants being brought into bearing earlier by the use of artificial light. It is remarkable that under these circumstances the yield in April did not suffer—whereas ordinarily it is often found that an early period of fertility is followed by a period of poor results later.

	No. of Cucumbers in March		No. of Cucumbers in April	
	Total	Per Plant	Total	Per Plant
Daylight only	17	0·07	3,875	16·1
Daylight and 500 watt in C. 10 hours	988 1,188	4·53	4,698 4,555	19·3
Daylight and 750 watt in C. 10 hours	1,069 1,164	4·65	4,560 4,684	19·3

One other conclusion to be drawn from these results is that the illumination yielded by the 500-watt lamps was apparently sufficient. No very material advantage was shown in the behaviour of plants in the area lighted by 750-watt lamps. It may be mentioned, as a matter of interest, that the Danish Electricity Works reduced the price of current to 0.07 Kr. (approximately 1d.) per unit for the purpose of these experiments.

Commercial and Industrial Lighting

By D. SPENCER-JOHNS

(Paper read at the Special Meeting of the Illuminating Engineering Society, held in the Assembly Room, at the Chamber of Commerce, New Street, Birmingham, at 5 p.m., on Monday, March 14th, 1932.)

I HAVE been invited to address you this evening on the application of good lighting to commercial and industrial interiors. My instructions are to generalize and avoid comparison and possible controversy, confining my remarks to good versus bad lighting; if, therefore, the address I am about to give is found by some members of this audience to cover no new ground, I must ask indulgence.

We live the greater part of our lives in a world of natural light of high intensity, and any alleviation of the darkness of night is apt to be accepted as a progressive step. As a community we are not yet sufficiently light-conscious to discriminate between good and bad lighting unless the effect of gloom is definitely apparent. Nevertheless, light has become a definite factor in our business as well as in our private lives.

We have no records of the time when artificial light was first available for the use of man. There is, of course, the legend of "Prometheus" in the Greek mythology. It is reasonable to assume that a brand taken from a fire was the first form of luminant employed solely as such. The hours of working and hunting were, however, still limited to those when the sun-god drove his chariot through the heavens.

Next in order would probably be hollow stones filled with animal fat, wicks of vegetable fibre immersed in vegetable oils, and finally the shaped vessels of pottery and of metal, which ultimately evolved into the paraffin lamp with its glass chimney and wick regulator.

The candle, or rather the tallow dip or taper, is of a later date, although it was certainly employed long before the Christian era. Candles had the evident advantage that they could be stored for future use and so easily carried from one point to another. The earlier candles, however, required constant snuffing of the wicks. This difficulty was not surmounted until comparatively modern times, when the advantages of sperm whale oil were discovered. The modest candle still has its place in our lives to-day.

The use of coal gas marked a definite advance in artificial lighting when it was discovered towards the close of the 18th century. We may congratulate ourselves upon the fact that it was introduced by an Englishman, William Murdock. Even in its inaugural stages, when fish-tail burners were employed, gas was a decided advance on oil and tallow. When, in 1885, Welsbach produced the first incandescent mantle, artificial lighting had already progressed from infancy to adolescence.

In 1831 Michael Faraday gave us electricity, and, toward the end of the last century, in 1879, Sir Joseph Swan, an Englishman, and Thomas Alva Edison, an American, evolved the first commercially practical electric lamp of carbonized fibre burned in a vacuum. (This new invention, indeed, actually preceded the introduction of the incandescent gas mantle, although illumination by means of electricity was not practised to any appreciable extent until long after.) This innovation again constituted a definite advance, since the source of light was contained in a sealed vessel and depended upon no outside supply of oxygen.

The original carbon lamps were of low efficiency and gave place to vacuum lamps with tantalum and tungsten drawn-wire filaments, which in their turn were replaced by the gasfilled lamp in general use to-day.

The introduction of incandescent light-sources has made the past 50 years years of progress, but apart from the gain in intensity of light there is also the question of *colour* to be considered. The light from the earlier forms of luminants held a preponderance of the red and yellow rays in the spectrum, but the incandescent light-sources emit a higher percentage of the green and blue rays. Green and blue, with such neutral tints as grey, are the colours of nature, and are considered to be more restful to the optic nerves than the reds and, to a less degree, the yellows. Furthermore, the closer resemblance of the spectrum of modern artificial illuminants to that of daylight facilitates the perception of coloured objects in their true perspective.

The Effect of Light on Vision.

Intensity of illumination has a pronounced effect upon acuteness of vision; there is a time factor in seeing just as there is a time factor in the exposure of a photographic plate or film; indeed, the eye is in every way comparable to a camera, except that it is a more delicate and more highly adjustable piece of mechanism.

The saving of time is the essence of business economy, and we effect such economies by substituting all kinds of mechanism for the hands. Now, if the lighting is improperly distributed and of inadequate intensity, the eye is forced to take a time "exposure" instead of a "snapshot," and the result is delay and eye strain. Certainly the eye focuses its view in less time than the camera, because of its more ready response to light, but the result is the same in ratio. The eye has, through centuries of usage, become familiar with intensities in the order of, say, 20 to 100 foot-candles (which corresponds to the waning of light before sunset) and to some thousands of foot-candles, the intensity obtaining from an unrestricted sky at midday on a bright summer day. Although it is not an economic possibility to reproduce full daylight intensities at night, an attempt should at least be made to furnish adequate illumination according to the minima accepted by illuminating engineers. Nearly 50 per cent. of the workers of to-day suffer consciously or unconsciously from astigmatism, and tests have shown that such people benefit even more in ratio to increases in intensity than they whose eyes are perfect.

The following figures summarize the results of a test made of the ability of a person to read 100 words in Old English type, printed in black (*a*) on a white background and (*b*) on a medium grey background, by varying degrees of illumination:—

Illumination Foot-candles	White Seconds	Grey Seconds
2	17	32
4	15	26
8	14½	21½
16	13	18½

Thus we see that even in so automatic a process as reading (automatic because few people do more

than scan a word) an increase in intensity effects a saving in time. It will also be noticed that the greater contrast-factor of black and white compared with that of black and grey also assists visual acuity.

A further instructive test carried out in the inspection shop of a large mill in which ball and roller bearings are made may be quoted. When the intensity was raised from 5 foot-candles to 20 foot-candles (representing an increase of only 1s. 2d. per hour in the cost of energy consumed) the increase in output was 12.5 per cent. Now the inspectors received in wages £2 15s. hourly. Hence the increased output is equivalent to a gain of 6s. 1½d. per hour to the company, an economy which should pay for the apparatus involved in a very short space of time. Furthermore, the higher intensity would make it easier to perceive minute flaws and fewer faulty bearings would therefore pass the examiner.

Glare is one of the most serious problems with which we have to contend. There are many installations still in operation where high-powered light-sources are used in conjunction with conical iron shades, such as were originally intended for use with light-sources of minor light output, or are shaded merely with a piece of brown paper or left entirely unshaded. Glare may also be caused by specular reflection from the polished parts of the plant or from materials such as sheet metal. Nature has provided us with eyebrows to shield the eyes from the brilliant sources of light arranged above, but there is no such protection in the case of glare from below. The use of diffusing surfaces surrounding the lamp and reducing the brightness of the source of light is helpful in diminishing glare of this kind.

The incandescent mantle and the incandescent electric lamp are the chief light-sources of to-day, but they do not, by themselves, constitute a lighting system. Light and illumination are no longer synonymous; the former is the cause and the latter the effect. Lighting practice, however, cannot be reduced to a set of stereotyped rules, supplemented by charts and diagrams. It is because illumination design involves imagination and a wide and varied fund of knowledge that we find it so interesting and appealing. The two phases of illumination which we have under review this evening, commercial and industrial lighting, are probably the two most prosaic in the whole schedule. I do not mean to imply that they are the least important; on the contrary, the manufacture and marketing of the wares we produce is of paramount importance to us all; I mean only to convey that there is more interest in the planning of a lighting scheme for a theatre or cinema, a church or a cathedral or in the flood-lighting of an imposing building in such a manner that the lighting system enhances and accentuates the architecture.

Systems of lighting may be divided into three classes—direct, semi-indirect and indirect. Indirect lighting is such that the whole of the light flux is directed upward from an opaque surface to the ceiling, and thence diffusely reflected downwards and is doubtless best from the æsthetic viewpoint. But the ceiling and walls should obviously be of a very light colour if efficiency is important, while protection against dust is essential. Although not *shadowless*, this system of lighting results in shadows so vague that they are hardly perceptible while the whole of the light-source is totally screened from view. Glare and specular reflection are thus eliminated. The conditions resemble those obtaining when a cloud is interposed between the sun and the earth. Direct lighting, on the other hand, approximates to the effect when the sun shines direct on to the earth, causing dense shadows and blinding us if we venture to look immediately upward.

Semi-indirect lighting follows the direct system, but it permits a modicum of light flux to escape directly downward through a translucent medium, while directing a maximum toward the ceiling.

Direct lighting is probably the system most generally applied to-day, and is the most " efficient " system in terms of foot-candles per unit of energy. There is, however, more risk of troublesome shadows, glare and specular reflection, so that the use of this form of illumination demands special care.

Whichever of the three systems is employed, it is important that the illuminating engineer should collaborate with the architect (except, possibly, in the more straightforward jobs). Modern lighting can serve the architect in two ways; it can furnish the proper and necessary lighting effects for practical needs, but it can also reveal to the best effect the architect's work if planned in relation to the architecture or as a component part of the whole structure. In the planning of new buildings the architect of to-day is groping for new modes of expression, and it is essential that the illuminating engineer should collaborate with him from the outset in order that adequate provision can be made for special effects.

Shop Windows.

Every storekeeper acknowledges the value of a well-lighted display window as his best and most economic form of advertisement. In ratio to the cost of the premises, the expense involved is negligible. Artificial light enables him to make his window work overtime in displaying its contents.

Good lighting enhances the status of the store. Tests have shown that people are readily attracted and will linger longer before well-illuminated windows, while they will pass those of less enterprising neighbours without a glance. They even prefer to walk on that side of the road which is the better illuminated. Colour, applied with discrimination, also has the power to arrest attention, particularly if the colours employed are varied at intervals of time.

The bright sources of to-day must be screened from view if the installation is to function with the maximum of efficiency. Dazzle impairs the " seeing-power " of the eye and tends to discount the actual intensity on the display. Asymmetric shop-window reflectors (adapted to the shape of the window) may be concealed behind a pelmet or valance at the top of the window, or arranged over a soffit or false ceiling so that the light-source is concealed from the view of the observer. When the window is exceptionally deep and reaches far back into the store, light may be furnished by some form of reflector unit flush with the ceiling.

Some of the larger emporia have realized the value of window space as an advertising medium, and have consequently provided arcades in which two-sided, three-sided and four-sided windows are arranged. In such cases there is a considerable risk of glare from points other than those normal to the angle of view, and it is therefore desirable to equip reflectors with shields in which glare louvres are provided, or, in the case of three-sided and four-sided windows, with a double pelmet; the first pelmet arranged between the reflectors and the window and the second pelmet suspended immediately behind the reflectors to a depth such that the distribution of light flux is not disturbed while the filament is adequately masked from the opposite side of the window. Spotlights may be used to

"pick out" some central feature as the principal centre of attraction. Wide-angle floodlights may be installed as augmentary points for providing after-hour lighting to a lower intensity.

Large plate-glass windows in wide thoroughfares are apt to act as mirrors and reflect the outline of the buildings opposite. It is possible to lessen this inconvenience by adopting a light material for the backs of the windows and by illuminating the interior to a very high intensity. The façade of the modern shop frequently lends itself to some form of artistic exterior lighting, enhancing its appearance and increasing its arrestiveness. Luminous signs also have very considerable advantages, more particularly those which project at right angles to the building, since they are more easily perceptible to persons approaching.

The intensity of illumination provided for a window display is naturally determined by the position of the premises and the brightness or dimness of the surroundings and by the nature of its contents.

Interior showcases, wall cases and glass sales counters are miniature shop windows, and the importance of correct lighting equals that of the outside display windows. These cases are silent salesmen, and they should attract the attention of the shopper when inside the store; consequently they should stand out brightly against the surroundings and be more brightly illuminated than the general area.

Shop Interiors.

As in the case of the windows, the lighting of the shop interior has a marked effect on the sales. The appearance should be inviting and illumination ample to enable the customer to inspect merchandise with ease. Obviously, the character of the business will have an influence upon the lighting system, and decorative appearance (which is quite compatible with good engineering practice) may be an important consideration. The lighting system should, in general, be unobtrusive, and should form a part of the "atmosphere" of the store. "Architectural" lighting has, however, recently been more widely adopted in this country, and some really attractive effects have been obtained in interiors which are suited to such systems. Cornices, architraves and wall panels of luminous glass, imitation windows and laylights in the ceiling may be employed individually or compositively to create an arresting effect. Such systems can be made quite efficient in operation by the use of scientifically designed reflectors arranged *behind* the glass, although it is sometimes difficult to obtain even distribution of the light.

Industrial Lighting.

Well-designed light systems are an asset to industry, tending, as they do, to reduce production costs. The factory cost controls the selling price of the finished product. It is therefore the aim of every works manager to cut down the cost of manufacture to a minimum. Good lighting plays an important part in factory economy. It is impossible to furnish an exact estimate of the percentage of manufactured goods produced under artificial light, but perhaps a normally busy factory or mill would operate for about 400 hours per annum (at a conservative estimate) under artificial light as compared with, say, 2,200 under daylight. Now, diminutions of output varying from 10 per cent. to 25 per cent. have been recorded under artificial light, according to the inadequacy of illumination provided. A midway figure of 17½ per cent. represents a fall of 2.7 per cent. on the year's production, i.e., the plant operates for eight whole days a year with absolutely no result. Spoilage, faulty production and accidents are all liable to result from inadequate lighting. Competent authorities have declared that good illumination would prevent 25 per cent. of avoidable accidents.

We British are, as a race, notably conservative, but the time must come when our industrialists will realize that a capital sunk in correct lighting systems is a remunerative investment. It will frequently be found that the annual cost of lighting a works or mill is *reduced* by the use of more scientifically designed equipment.

Industrial lighting systems may be divided into three classifications—general lighting, localized general lighting, and general lighting supplemented by local points. Localized lighting by itself is unsatisfactory, since it results in bright zones in the midst of gloom and imparts a feeling of depression to the workers.

A general lighting system may be described as one which has for its objective the equitable distribution of light flux over the entire area of the shop so that work can be carried on at any point with equal facility while the layout of plant can be altered without the necessity for revising the lighting system. One advantage is that a comparatively small number of large lighting units can be employed, reducing installation and maintenance costs. Such a system may, however, prove unsuitable for work of a very fine character, although it is eminently suited to large, high interiors where manufacturing processes are condensed into reasonably small areas and the total area of the shop utilized (e.g., to packing, assembly work, machine sewing, canning and bottling, general machine work, painting by spraying or by brush, and to similar processes). It has the advantage of providing a good intensity of illumination on vertical as well as upon horizontal surfaces.

Localized general lighting is similar in principle, but is so arranged in relation to the plant that a maximum intensity is supplied where it is most needed, while alley-ways and areas employed for storing raw and finishing materials are less intensely illuminated. Localized general lighting is applicable to such purposes as bookbinding, benchwork of all kinds, some machine shops, printing, woodworking, textile manufacture and similar operations.

Where work of a detailed character such as engraving, sewing, fine lathe work or precise drilling is carried out it is advisable to furnish local lighting points, adequately shielded from view and directed toward the work at an angle such that there is no risk of specular reflection into the eyes of operatives. These points are intended merely to provide illumination of high intensity at the points of maximum importance. They are supplemented by general lighting, which serves to avoid acute contrast in intensity and also to illuminate the less important locations. The installation of local points tends to increase the initial cost of the installation, and there is some risk of premature breakage of the light-source owing to the ease with which it can be knocked, but they are frequently indispensable.

In selecting the lighting unit, due consideration should be given to the mounting height and the spacing centres, which are determined largely by the construction of the buildings; spacing rules, in accordance with the distribution characteristics (dispersive, intensive and focussing) of lighting units can, however, usually be followed to a great extent.

The application of indirect lighting in works premises is limited, but it can be employed with advantage in drawing offices where dense shadows

are the source of considerable annoyance to the draughtsman, and also in hand-fed sewing-machine rooms, and such industries as needle manufacturing, where specular reflection is particularly acute. A flat white ceiling is essential and is not always available, but an alternative lighting system may be planned to incorporate a form of dispersive-type reflector with a globe of opal glass surrounding the light-source: this globe reduces the surface brightness of the source and helps to reduce the annoyance resulting from specular reflection and renders possible shadows quite vague.

The intensity of illumination necessary for efficient working varies, naturally, according to the rough or detailed character of the operations involved, and is also controlled by the light or dark colour of materials and the periods during which the lighting system is left uncleaned. Illuminating engineers have adopted schedules of intensities applicable to the more general industries. It is satisfying to notice that a great advance has been made during recent years toward the illumination values which will enable work to be carried on at the same rate of production as during daylight hours.

The regular maintenance of a lighting system is of paramount importance if full value is to be obtained for the initial outlay and the annual cost of energy consumed. Rapidity of depreciation will depend upon the amount of dirt and other foreign matter in the atmosphere, but, even in the cleanest of workshops, humidity will cause the units to lose their original efficiency after a time. Allowance should be, and generally is, made for this before the system is installed, but it would be an excellent thing if the works' electrician were to keep a portable lumeter or foot-candle meter available and take readings at regular intervals to ensure that a minimum illumination value should be maintained.

Office Lighting.

The lighting of offices resembles the non-architectural forms of shoplighting so closely that it is unnecessary to deal with the subject in detail. It is merely necessary to stress the fact that illumination of adequate intensity and the elimination of dense shadows and glare are as indispensable for the comfort and efficiency of the office staff as for the works people, while callers can be impressed favourably or unfavourably, according to the impression made on them by those parts of the premises which they normally view.

Obviously, the arrangement of desks, typewriting tables and filing cabinets will largely determine the layout of the system unless semi-indirect or indirect lighting is employed, when the arrangement of fittings may be symmetrical without greatly affecting the placing of the office furniture.

Floodlighting.

I suppose that an address of this character would be incomplete without some reference to the application of floodlighting to commerce and industry. Floodlighting is one of the most *emphatic* methods of advertising, and is still sufficiently a novelty to have a general appeal.

A sign, poster or hoarding can be made to advertise wares long after daylight fades, and has the advantage of attracting the attention of persons it would not normally reach—persons who spend their day away in the city. It is a less expensive item to install and maintain than the luminous sign, and affords greater elasticity of wording and form.

The floodlighting of buildings has less vogue in this country than abroad, partly because its value has yet to be realized and partly because our buildings, being of older construction, are less adapted to the purpose. A floodlighted building stands out clearly from adjacent structures and forms as valuable a medium for attracting attention as a sign or poster, although the company should be one sufficiently well known that the type of its manufactures occurs to the mind concurrently with sight of the building.

A castle or ancient monument which is floodlighted at night serves to attract attention to the town in or near which it is located. In my own experience, a considerable amount of money has been spent in quite small towns because of the influx of visitors who have merely made the journey in order to view what is to them a novelty.

There is without doubt a considerable amount of untouched business in this country which will ultimately benefit the artificial-lighting industries, supply companies, the manufacturers of fittings and light-sources, as well as the manufacturers of accessories, conductors, piping, etc. Some day no doubt the importance of good illumination will be universally realized, and the effects produced by light will have the same artistic appeal as music, good literature and the drama. We, gentlemen, are the missioners to those purposes, and on this note I shall conclude!

Some Observations of Lighting in Factories

By P. E. SHOPLAND (H.M. Inspector of Factories)

(Paper read at the Special Meeting of the Illuminating Engineering Society held in the Assembly Room, at the Chamber of Commerce, New Street, Birmingham, at 5 p.m., on Monday, March 14th, 1932).

THIS paper deals principally with the lighting conditions found in factories engaged in the light engineering and electrical trades, including the manufacture of wireless apparatus, the silversmiths' industry in the Sheffield area, and iron-founding. The factories visited were chosen at random and without knowledge of the conditions obtaining in them before visiting. Two hundred and twenty-two factories were visited during the inquiry, and 1,130 photometer readings taken in 54 of them.

Illumination is chiefly by electricity, but in some cases incandescent gas (and in a few cases even fish-tail burners, candles and paraffin lamps) were found in use. Glare was common, owing to the use of the old shallow, flat and conical reflectors with both general and local light-sources, and bare lamps even up to 1,000 watts were frequently found. In many works in which high intensities were provided on the working planes it could not be said that lighting was good, on account of the glare that was frequently present from numerous sources. Unfortunately, many people conclude that if a brilliant light-source is provided that is all that is required. They are more concerned with the provision of the source than its adequacy where the illumination is required, and herein lies the problem that is being confronted and which is being tackled by illuminating engineers to-day, to educate the factory occupier, his operatives and the public generally to distinguish between the means of producing light, and light itself, on the plane where it is required.

Generally speaking, the consumption of both electricity and gas in most factories is sufficiently high to provide good illumination if reflectors of the correct type are used, cleanliness is observed, and the mounting heights and spacing are arranged carefully. By so doing, in many cases, it would even be possible to lower the consumption and thus one of the overhead charges. Very useful data, showing how output and quality of work has been increased, with an improvement in the temperament and reduction of fatigue of the operatives, has been obtained. The use of this data has been found to be an infallible way of obtaining live interest in the subject, because in the past lighting has been one of the last considerations, and has received very little attention from many. To-day the subject has certainly received a small stimulus, but the use of concrete evidence showing benefits and saving that may and have been obtained is, in my opinion, a very useful weapon in awakening interest in those who have hitherto looked on this subject as of secondary, or even minor, importance.

A table has been drawn up showing the percentages of photometer readings that were found to be below or above the standards recommended in the Third Report of the Home Office Departmental Committee on Lighting in Factories and Workshops and the Geneva Code of 1924. Only the principal processes in which a reasonable number of readings were taken are shown, and from this table it will be seen that a large percentage err on the wrong side of the recommendations. But even when the intensities are reasonably high, unfortunately in too many cases otherwise good illumination is marred by the prevalence of glare, and where general lighting only is used, by uneven distribution and presence of shadows. A rough attempt was made to classify glare under four headings, i.e. (1) factories in which it was absent; (2) where due to a small number of sources only; (3) where bad; and (4) where very bad. Fifteen per cent. came under Class (1); 16 per cent. under Class (2); 17 per cent. under Class (3); and 52 per cent. under Class (4). Now, if we can persuade people to eliminate glare we automatically increase intensities and reduce eyestrain and fatigue, but I have found it necessary to have proof of this to awaken interest and desire to improve present installations. Consequently cases have been quoted where research work has proved that good lighting has lessened fatigue and substantially improved output. Also it is frequently necessary to show how improvements can be effected at low cost. Many firms are reluctant, and even cannot afford to-day, on account of the bad state of trade and their low financial position, to spend money on new lighting installations and fittings. But if we can persuade them to adopt measures which, if not altogether giving them maximum results, at least greatly improve illumination with very little added cost, such as by the modification of such fittings as the shallow conical or flat dispersive type by the provision of home-made skirts, frequent cleaning of same and replacement of lamps at the end of a reasonable life, it is a step towards the ultimate provision of scientific lighting, and I have found that once the benefits of slight improvements have been realized that step is only the preliminary to far greater improvements. These remarks are based on re-visits paid to factories visited in previous winters where it has been found that many improvements have taken place and far greater interest shown in this subject. As an example, in certain works where there was previously no regular time for cleaning fittings, this is now done at regular periods, and lumeter tests have shown an increase of 33 to 50 per cent. in the illumination. Additional light-sources have been found in others, perhaps even doubling the previous intensities. In one particular case, relighting on modern lines has resulted in an increase of 10 per cent. earned by the operatives during the winter months, and in another instance a firm quoted an increase of 40 per cent. on output during the artifcial-lighting hours in comparison with the previous winter.

I will now deal with a few processes and intensities of illumination in detail.

Power Presses.

Sixty per cent. of these machines were provided with less than 2 foot-candles. This is totally inadequate, especially when we take into account the dangerous character of this work. I am sure all of you will agree with me on this point, as you must be very conversant with this type of machine, which is used so extensively in the Midlands and on which unfortunately we hear of so many serious accidents.

TABLE OF INTENSITIES

Trade and Processes	Percentage of Intensities				Minimum recommended intensity in the	
	Under 3 ft.-c.	3 ft.-c. or over	Under 5 ft.-c.	5 ft.-c. or over	Third Report of the Home Office Departmental Committee on Lighting in Factories and Workshops in Foot-Candles	Geneva Code, 1924, in Foot-Candles
Light Electrical Engineering:						
Fine turning			17	83	5	5
Assembling small parts			19	81	3	5
Armature winding			33	67	3	3
Wireless Apparatus:						
Fine assembling	8	92	41	59	3	5
Fine turning			33	67	5	5
Fine coil winding			10	90	3	3
Clerical work	50	50	90	10	—	3
Light Engineering:						
Precision grinding	4	96	22	78	5	5
Assembling	18	82	40	60	3	3
Fitting and fine bench work	17	83	44	56	3 (5 for tool room operations)	5
Power press work	29	71	41	59	3	2
Packing	36	64	86	14	—	2
Ironfounding:						
Moulding by hand	58	42	90	10	·4	·5
Silversmiths:						
General bench work	8	92	49	51	3	3
Polishing and inspection				100	5	5

Precision Grinding.

The average intensity on this class of machine, where work is performed to very fine limits, frequently to a fraction of a thousandth of an inch, was 8 foot-candles. A good adjustable local source, preferably of the bracket type, is recommended here, so that the operator can adjust same to his own requirements.

Armature Winding.

An average of 6.25 foot-candles. Good local lighting, adjustable, is required for this work, which varies in its degree of fineness.

The packing departments in the electrical industry were reasonably well illuminated, 3.9 foot-candles being the average, but in many works in this industry the general illumination provided for assembling was poor, the distribution being most uneven, many operatives working in shadow on this account. About 60 per cent. of the readings were under 4 foot-candles for processes not of a fine character, but a higher standard would be advantageous.

In the wireless industry we get an average of 5.2 foot-candles for assembling. This certainly appears to be a low standard for this fine class of work. For coil winding, with wire often as fine as 47 gauge, we get 11.25 foot-candles. Good adjustable local lighting is necessary on these machines, both from the fineness of the material used and the importance of watching the revolution counter on each machine, the figures on which are in most cases very small, and accuracy in reading is extremely necessary.

In the engineering industry the average intensity was 2.9 foot-candles for rough turning, which is certainly too low, and for fitting and very fine bench work 5.25 foot-candles. Requests to test intensities in a few drawing offices, which were really outside the scope of this inquiry, revealed a very low standard in these cases, where general lighting only was provided either by the direct or semi-indirect system, giving between 3 and 4 foot-candles on the drawing-boards. This, you will agree, is totally inadequate for this work, where, in my opinion, well-shaded adjustable local light-sources should be fitted to each board. Similar or even worse cases were found in offices used for clerical or typing work with only 1.5 to 2 foot-candles of illumination, many persons working in deep shadow through a bad general arrangement of the system and an inadequate number of light-points.

In the few works visited in the ironfounding industry during last winter the conditions were found to be bad. Sixty-three per cent. of the readings were below 3 foot-candles, and only 7 per cent. over 5 foot-candles. In the majority of these factories the fittings are only cleaned at the commencement of the winter, while, in reality, it is essential, on account of the atmospheric conditions in foundries, that they should be cleaned very frequently, in fact weekly, if possible. If an overhead crane is used it is desirable to fix a light-source on the underside to travel with it, so as to avoid the slinger working in shadow at times; but this practice is not generally adopted. An intensity example of the benefits to be derived from good lighting is that of one foundry occupier who increased the intensity from 2.5 to 7 foot-candles, and found during the following winter that the bonus earned by the workmen under similar conditions to the previous winter increased by 7.5 per cent; also that there was a great improvement in temperament.

A short inquiry into the conditions in the silversmiths' industry revealed that they were extremely bad, no standard of illumination being aimed at for the individual processes, and extremely haphazard methods adopted. Bare lamps, up to 100 watts, is quite a common practice, frequently being placed at eye-level. On account of the extremely depressed state of this trade, it is very difficult to persuade occupiers to spend money on improvements in this direction. But a fair amount of success was achieved in persuading them to do something to eliminate the glare. It is difficult to persuade some people that improvements can really be effected, and cheaply, unless it is possible to demonstrate and prove it directly to them. Consequently it was arranged at one works that a suitable skirt should be made to fit an old shallow metal conical reflector, and that tests be carried out thereon. A reading from a bare lamp over a bench gave 7.5 foot-candles; a shallow reflector was then fitted, giving 13.5 foot-candles. The skirt was then added, eliminating all glare, and a reading of 19.5 foot-candles was obtained. I may add that this could have been improved upon, as the skirt had not been white enamelled, the surface being of plain metal. This test was sufficiently conclusive to prove the wastage through the use of bare lamps or the presence of glare, but it also shows that a great saving in lighting expenses can be made by, in many cases, reducing the size of lamps to get the correct standard of illumination with the use of the correct type of reflector.

Visits were paid to various works in which a similar inquiry was held in 1913-14. Charts showing where readings were taken at that time were used. In some cases, structural alterations and rearrangement of plant prevented useful comparisons being made, although unfortunately in one or two cases the latter had occurred without any alteration in the lighting system, the condition thereby being decidedly worse. An improvement had been effected in the heavy turning in the engineering industry and in the foundries visited, the standard being approximately doubled, but this is still far too low. As an example, in one large foundry, where the standard was 0.3 foot-candles in 1913, it is 1 foot-candle to-day. I may add that a more complete inquiry into the lighting of iron foundries has been carried out during this winter, and the results show a very low standard.

A few miscellaneous industries were visited, and certainly deserve reference. Tile moulders in earthenware works were found endeavouring to perform with the illumination from one candle only to each operator, even then not generally placed in the most advantageous position. In another similar works paraffin-burning cast-iron duck lamps were the only means of lighting, these having to be used at all times, the daylight being so bad in this works.

It appears extraordinary to me that the subject of cleanliness of lighting fittings does not receive more attention. In a very small percentage of works it is frequently done, but in the great majority it is absolutely neglected. Its importance is not realized until the losses in illumination (often 30 per cent. or more with only surface dirt) and the consequent losses in output and quality of work and the bad effects on health are pointed out. There is no doubt that a greater interest is now being taken in the subject of good illumination, but at present that interest has not extended sufficiently. I have been in the happy position of being able to preach the gospel of good lighting and to stimulate the interest of people who have the knowledge that I am not trying to sell them something! If I had been, I might have had greater difficulty in getting them to listen. As it is, I feel my position was one of advantage, and that the short talks I have had on this subject with many will bear good results.

DISCUSSION

Dr. JOHN W. T. WALSH, in opening the discussion, congratulated the authors and expressed his interest in the survey undertaken by Mr. Shopland, which recalled his own investigations in 1913-1914. The lighting conditions in many factories then was appalling. Though he was glad to hear that matters had improved it appeared that things were still moving but slowly. Perhaps the present industrial depression was largely responsible. Up to a certain point an increase in efficiency had a definite economic result. In the United States people were being apparently educated to demand a standard considerably higher than that prevailing here. Much of the progress of past years was due to the work of members of the Illuminating Engineering Society, and he was therefore very glad to hear of the project of forming a local centre of the Society in Birmingham.

Mr. H. ALLPRESS likewise expressed his appreciation of the papers, which were of an informative and non-controversial character. In Birmingham the commercial aspect of lighting was an exceedingly important one. He, too, welcomed the suggestion that a local centre should be formed.

Mr. J. S. DOW referred briefly to several problems mentioned in the papers, notably foundry lighting. He was glad to hear that the old impression that foundry work must be conducted in semi-darkness was now giving way to the belief that moderate general illumination was an advantage. Mr. Dow also referred to the special requirements of different industrial processes, some of which demanded high local lighting in addition to moderate general illumination.

The CHAIRMAN (Mr. S. T. Allen, Manager of the Central England Area of the Central Electricity Board) proposed a vote of thanks to the authors of the two papers. Although much had been done since the Illuminating Engineering Society was founded 25 years ago, much remained to be done. During that long period there had been no local centre in Birmingham, and he hoped that this condition would be amended. In his subsequent remarks the Chairman emphasized the importance of good lighting in relation to health and safety. It was remarkable that the consumption in many existing installations would suffice to give quite good illumination if only the light was wisely applied. In this connection he recalled his own efforts in Carlisle many years ago, when he endeavoured to induce shopkeepers to use concealed lighting for their windows instead of displaying unscreened bulbs in the range of vision of customers.

The vote of thanks having been seconded by Mr. W. Y. Anderson, and declared carried unanimously, the meeting then proceeded to discuss the formation of a local centre, as reported in our last issue.* A resolution in favour of the project was passed and a provisional committee established. A vote of thanks to the Chairman terminated the proceedings.

Progress in Decorative Electrical Illumination

Proceedings at the Meeting of the Illuminating Engineering Society, held in the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 6-30 p.m., on Tuesday, April 26th, 1932.

A MEETING of the Illuminating Engineering Society was held at the House of the Royal Society of Arts (18, John Street, Adelphi, London, W.C.), on Tuesday, April 26th. Members and friends assembled for light refreshments at 6-30 p.m., and in the absence of the President the chair was taken by Lieut.-Commander Haydn T. Harrison at 7 p.m.

After the minutes of the last meeting had been taken as read the Hon. Secretary read out the names of applicants for membership, which were as follows:—

Sustaining Members:—

The London and Home Counties Joint Electricity Authortiy. 5, Millbank, London, S.W.1. *Representative*: Mr. W. F. Marchant, O.B.E.

Corporate Members:—

Beck, F. N. ....Public Lighting Engineer, Shropshire, Worcestershire and Staffordshire Elec. Power Co. Ltd., 263, Monument Road, Edgbaston, Birmingham.

Bennett, G. H. ....The British Oxygen Co. Ltd., 123, Victoria Street, London, S.W.

Lupton, E. A. ....Elec. Engineer and Contractor, 10, Davies Street, Berkeley Square, London, W.1.

Penwarden, E. H. ....Chief (Fittings) Designer, The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2.

Country Members:—

Schofield, L. D. ....Illuminating Engineer, Beau Regard, Brentwood Crescent, Altrincham, Cheshire.

The names of those announced at the last meeting of the Society were read again, and these gentlemen were formally declared members of the Society.†

The CHAIRMAN then called upon Mr. E. H. PENWARDEN to read his paper entitled **"Progress in Decorative Lighting."** The paper, which was illustrated by exhibits and a comprehensive series of lantern slides, reviewed progress in the design of lantern fittings from 1913 (when a paper on this subject was read before the Society by Mr. F. W. Thorpe) up to the present day. Allusion was made to various questions involved in decorative lighting, such as the predetermination of illumination in the case of unusual lighting schemes and the basis of co-operation between the architect, the fittings designer and the illuminating engineer.

An interesting discussion ensued in which the following, amongst others, took part: Mr. T. P. BENNETT, Mr. F. G. THOMSON, Mr. W. R. RAWLINGS, Mr. G. ALASTAIR MACDONALD, Mr. B. B. BLACKBURN, Mr. F. L. CALVERT, Mr. A. CUNNINGTON, Mr. P. R. ALLISON, Mr. A. G. BROWN and the CHAIRMAN.

In the course of the proceedings a communication in writing was presented by Mr. F. W. Thorpe.

After a vote of thanks to the author had been proposed and declared carried with acclamation, the CHAIRMAN announced that the next gathering of the Society would take the form of a joint meeting with the Association of Public Lighting Engineers, and would be held at the E.L.M.A. Lighting Service Bureau (15, Savoy Street, Strand, London, W.C.), at 6-30 p.m., on Tuesday, May 24th, when a paper on "The Work of a Public Lighting Department" would be read by Mr. E. Marrison.

* *Illuminating Engineer*, April, 1932, p. 91.
† *Illuminating Engineer*, April, 1932, p. 100.

Literature on Lighting

(Abstracts of recent articles on Illumination and Photometry in the Technical Press)

(*Continued from Page* 102, *April*, 1932).

Abstracts are classified under the following headings: I, Radiation and General Physics; II, Photometry; III, Sources of Light; IV, Lighting Equipment; V, Applications of Light; VI, Miscellaneous. The following, whose initials appear under the items for which they were responsible, have already assisted in the compilation of abstracts: Miss E. S. Barclay-Smith, Mr. W. Barnett, Mr. S. S. Beggs, Mr. F. J. C. Brookes, Mr. H. Buckley, Mr. L. J. Collier, Mr. H. M. Cotterill, Mr. J. S. Dow, Dr. S. English, Dr. T. H. Harrison, Mr. C. A. Morton, Mr. G. S. Robinson, Mr. J. M. Waldram, Mr. W. C. M. Whittle and Mr. G. H. Wilson. Abstracts cover the month preceding the date of publication. When desired by readers we will gladly endeavour to obtain copies of journals containing any articles abstracted and will supply them at cost.—ED.

II.—PHOTOMETRY.

92. Brightness, Divergence and Subjective Brightness. A. Blondel.

R.G.E., 31, *pp.* 333-345, *March 12th*, 1932.

Discusses mathematically the various relations existing between source brightness, beam divergence and subjective or apparent brightness with particular reference to their application to photometric measurements. W. C. M. W.

93. Calculation of Horizontal Illumination Diagrammes. E. Meyer.

Licht u. Lampe, 7, *p.* 99, 1932.

Description of a graphical and a mathematical method of calculation and a comparison of the two. E. S. B-S.

94. Fog. Penetration of Different Lights. Anon.

El. World, 99, *p.* 535, *March 19th*, 1932.

Gives conclusions arrived at by S. H. Anderson with regard to the fog-penetrating power of various lights. M. W. C. W.

III.—SOURCES OF LIGHT.

95. Lamp Making in Sweden. A. E. Fristedt.

El. World, 99, *pp.* 580-582, *March 26th*, 1932.

Describes the process of mass production of electric lamps as now practised in a large lamp factory in Stockholm. W. C. M. W.

96. Photoflood. R. E. Worstell.

Light, 2, *No.* 6, *p.* 9, *March and April*, 1932.

This lamp was developed for photography. It is similar in bulb size to a 60-watt lamp, but owing to its high operating efficiency its photographic effectiveness is equal to that of a 750-watt general service lamp. The life is about two hours. The lamp is used with a reflector, and should be of particular service to amateurs. Tabular data are given connecting distance, aperture and exposure. C. A. M.

97. Ultra-violet Luminaires for S.2 Lamps. H. G. Schiller.

Light, 2, *No.* 6, *p.* 27, *March-April*, 1932.

Photographs are given of a number of American floor and table standards available for use with S.2 lamps. C. A. M.

98. The Window as a Source of Light. W. C. Randall and A. J. Martin.

Foot-candle readings were taken in one half of a full-sized room which was lighted through the window by an artificial sky. Utilization factors are worked out for the room with various windows and drapings. Comparisons are made with artificial light. G. H. W.

99. The Status of Natural Lighting in Modern Building Codes. G. W. Thomas.

Am. Illum. Eng. Soc., Trans., 27, *pp.* 289-302, *March*, 1932.

A brief review of nearly one hundred building codes reveal that practically all such codes are deficient in directing attention to the fundamental factors of good natural lighting. The several practical methods for determining the merits of a building design from the standpoint of adequate and satisfactory natural lighting are reviewed, and suggested rules are presented. G. H. W.

IV.—LIGHTING EQUIPMENT.

100. Lighting Equipment. Anon.

Elec. Rev., 110, *p.* 487, *April 1st*, 1932.

Gives details and illustrations of the latest lighting fittings produced in glass and metal. G. S. R.

101. Street Lighting in Cascade. Anon.

Elec. Rev., 110, *p.* 488, *April 1st*, 1932.

Gives diagrams and particulars of two methods of switching street lights from a central position. In the first a master switch controls the first group of lights and the operating coil of a contactor. This controls the second group, and so on in succession.

The second circuit is similar, but needs a pilot wire, and is more flexible. G. S. R.

102. New Ideas in Floodlighting. H. T. Crane.

El. World, 99, *pp.* 534-535, *March 19th*, 1932.

At the new floodlighting installation of the Southern California Edison Co., in Los Angeles, the light intensities are controlled by thyratron tubes working in conjunction with motor-driven regulators. The entire system is made automatic by means of synchronous time-clocks. The floodlights are mounted on movable concrete bases. M. W. C. W.

103. Advances in the Sphere of Discharge-tube Plant. W. Starke.

Licht u. Lampe, 6, *p.* 80, 1932.

With the use of discharge tubes for advertisement the improvement of electrodes permits the use of smaller electrodes for electric signs and consequent improvement of the letters. Transformers are now made so small that they can be built into letters, facilitating the installation of signs which are to be frequently changed. Cable-like conductors have been developed. The production of glowing cathode or high-power tubes permits a great increase in power without a correspondingly large increase in current. They can be made with many colours, and are used in aviation, film reproduction, colour separation, signalling, etc.. The paper finally deals with daylight apparatus describing the method whereby the gas filling is produced from the inside of the tube by means of an auxiliary electrode. E. S. B-S.

V.—APPLICATIONS OF LIGHT.

104. A Revolution in Cinema Projection. Anon.
Architect and Building News, *p*. 364, *Vol CXXIX*, *No*. 3,300, *March* 18, 1932.

Describes how by projecting from the stage on to a screen in the auditorium, and by replacing the existing screen by a mirror, an equally good view is obtained from all seats. The virtual image is seen several feet upstage, and there is foreshortening or fatigue to those sitting in front or side seats. Dr. R. T. A. Innes has been responsible for the per fection of the scheme. H. M. C.

105. When Light is Cleverly Applied. A. Rogers.
Light, 2, *No*. 6, *pp*. 24-5, *March-April*, 1932.

Gives an illustrated account of the Weston Union Building, N.Y. City. Describes novel corridor equipment comprising bronze wall fittings at 12 ft. spacing, each equipped with a 250-watt floodlighting lamp with a metal reflector. In the auditorium, general lighting is produced by 500-watt tubular projector lamps with spherical glass mirrors at the base of six tall windows. C. A. M.

106. Architectural Lighting of Public Buildings. Anon.
Am. Illum. Eng. Soc., Trans., 27, *pp*. 261-274, *March*, 1932.

After a general discussion, eight illustrated descriptions of modern lighting schemes are given. G. H. W.

107. Picture Gallery Lighting. Anon.
Elec. Rev., 110, *p*. 528, *April 8th*, 1932.

Gives three illustrations and a brief description of the lighting of the Atkinson Art Gallery, Southport. G. S. R.

108. Lighting a Small Art Gallery. Anon.
El. World, 99, *p*. 494, *March 12th*, 1932.

Describes the lighting of a small combined art gallery and auditorium at the public library at Winchester, Mass. W. C. M. W.

109. Lighting Poultry Pens. I. W. R.
Elec. Times, 81, *p*. 420, *March 31st*, 1932.

The artificial lighting of poultry pens will, if properly used, increase the egg yield without ill-effect on the birds by lengthening the working day in winter, thus producing a greater output when egg prices are high. The best method is to arrange a uniform working day of 14 hours, concluded by a dimming period to allow birds to regain their perches. Fittings should be arranged about 6 ft. above floor level, and a 40-watt lamp will cover 200 square feet. A table is given showing that in a test over 48 weeks an additional net income of 38 per cent. was obtained. G. S. R.

110. Synthetic Lighting. G. E. Shoemaker.
Am. Illum. Eng. Soc., Trans., 27, *pp*. 308-323, *March*, 1932.

Suggests that lighting requirements should be analysed into the fundamental light-beams or distribution patterns which can best be combined to produce the effects desired. Examples of applications to display, store drafting room and other forms of lighting are given. G. H. W.

111. Lighting the Modern Inn. R. L. Zahour.
El. Journal, *Vol*. 29, *No*. 3, *p*. 118, *March*, 1932.

A general discussion of the requirements of modern hotel lighting in America. J. M. W.

112. Floodlighting for Fire Fighting. Anon.
El. Journal, *Vol*. 29, *No*. 3, *p*. 117, *March*, 1932.

Describes a floodlighting lorry used at Beaumont, Texas, equipped with a total of 16 floodlights and searchlights, ten of which can be taken into the building affected or on to neighbouring buildings. A 15-kw. petrol-driven generator is employed. J. M. W.

113. Southtown Theatre, Chicago. C. M. Cutler.
Light, 2, *No*. 6, *pp*. 21-23, *March-April*, 1932.

Particulars are given of lighting equipment in a new cinema in Chicago. The lighting of various architectural features, including the sign lighting of a tower nearly 200 ft. high, is discussed in detail. Coloured light is used extensively, and the total lighting load, including the floodlighting of the building and parking space, is 458 kw. C. A. M.

114. Light Speeds Flowers. Anon.
Light, 2, *No*. 6, *p*. 1, *March-April*, 1932.

Reference is made to experiments carried out at Ohio State University on the blooming of flowers by control of light conditions. Application of artificial light from ordinary small lamps is found both to accelerate blooming and to increase the size of the blossom. The economic aspect is touched upon. C. A. M.

115. Lighting of the Mansion House. Anon.
Elec. Times, 81, *p*. 427, *March 31st*, 1932.

Gives details of the reconstruction and relighting of the Egyptian Hall, with illustrations of the old and new lighting. The latter is indirect, and uses 176 reflectors at 18 centres, while the ceiling is lit with 30-watt striplite lamps. The illumination at floor level is about 5 foot-candles. G. S. R.

VI.—MISCELLANEOUS.

116. Ultra-Violet Reflection Factors. M. Luckiesh.
El. World, 99, *p*. 330, *Feb. 13th*, 1932.

Gives a table of reflection factors for different materials for ultra-violet light at $\lambda = 2967$. The best materials for dual-purpose reflectors are probably chromium and aluminium. W. C. M. W.

117. Photo-electric Recorder has High Sensitivity. C. W. Lapierre, A.I.E.E.
51, *pp*. 114-115, *Feb.*, 1932.

A new recorder has been developed which employs for the measuring and recording operations separate elements coupled together by a combined optical and photo-electric system. Tests show that the new instrument is as accurate, sensitive and responsive as a good indicating instrument. G. S. R.

118. The Problem of Motion-picture Projection from Continuously Moving Film. F. Tuttle and C. D. Reid.
J. Opt. Soc. Am., 22, *pp*. 39-64, *Feb.*, 1932.

A review is given of about nine systems for projecting motion-pictures, using continuously moving films instead of the intermittently moving film system which is universally employed. The motion of the film through the light-beam must be compensated by motion of lenses, prisms or mirrors. This involves more working parts than in the intermittent film system now used, but the continuous-film system, if perfected, might possess certain advantages, which are enumerated and discussed in this paper. T. H. H.

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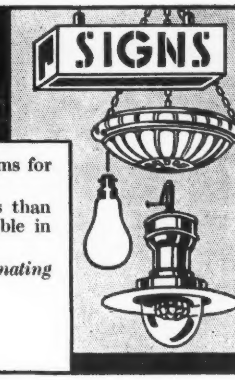

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The above pleasing photograph shows the floodlighting of the Keep of Cardiff Castle, the residence of the Marquess of Bute, on the occasion of the visit of Their Royal Highnesses the Duke and Duchess of York, on March 16th, when they were presented with the model Princess Elizabeth Home. The floodlighting was effected by means of G.E.C. projectors equipped with Osram lamps, and the installation was carried out by Messrs. Page & Stibbs Ltd., of Cardiff.

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A New Torchiere Floor Standard

The floor standard illustrated above, for which Messrs. Mortimer Gall & Co. Ltd. are responsible, is typical of modern methods, and we understand that several hundred are about to be installed in a big commercial building. The simplicity of this method of lighting is a great recommendation. It has been used in circumstances—e.g., for illuminating a dance hall—where one would hardly have thought it could answer successfully, but where the very soft, almost "shadowless" effect was found quite acceptable.

Incidentally we may mention that Messrs. Mortimer Gall & Co. have recently been responsible for a highly novel installation, a main feature of which is the complete elimination of fuseboards. The building, a retail showroom with a lighting load of 92 kw., is controlled and safeguarded by means of miniature circuit-breakers, which also operate as switches for the 300 lights. The method has now been in successful use for 18 months, during which period not a single service call has been received.

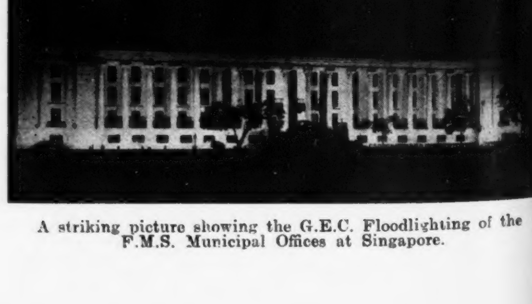
The Lighting of the New Sydney Harbour Bridge

The current issue of *The Wigan Review* (the journal of Messrs. Heyes & Co. Ltd.) illustrates the new Sydney Harbour Bridge, of which mention was made in our last issue. We observe that Messrs. Lawrence & Hanson Electrical Co. Ltd., of Sydney, who secured the contract for the supply of all the lighting fittings for the bridge, act as agents for Messrs. Heyes & Co., and that quite a number of the firm's familiar "Lacent" fittings are to be found in use on the bridge. We have thus another addition to the list of British firms who have contributed to the lighting of this huge structure.

Elsewhere in *The Wigan Review* we notice the continuation of the series of notes entitled "Twelve Epochs of Artificial Lighting." The current issue illustrates ancient and mediæval grease lamps, and reproduces a quaint Italian woodcut showing a banquet taking place by their light.

New Lighting for Piccadilly Circus

When the new lighting scheme in Piccadilly Circus, London, is completed (probably by about Whitsuntide) this spot will enjoy the almost unique distinction of coming under "Class A" in the British Standard Specification, which provides for a minimum illumination of 2 foot-candles. Whilst special efforts have been made to avoid glare, the aim has been to illuminate not only the streets but also the surrounding buildings and the Shaftesbury Memorial, with the famous figure of Eros in the centre of the square. Immediately round the Memorial will be four standards, each having a single lantern equipped with a 1,500-watt lamp. These standards will be of solid bronze, fluted and decorated with the arms of the City of Westminster. There are twelve other columns of cast iron (eleven already erected round the Circus), which will be painted to resemble bronze. Each will carry three 1,500-watt lanterns. The three-light standards are 26 ft. high, the others 22 ft. As each weighs about $1\frac{1}{4}$ tons, it is remarkable that there is only 6 ins. of pole under the pavement level. There is, in fact, a total depth of only 18 ins. to the ceiling of the Tube station under the Circus, so that special methods of securing the columns had to be devised. Naturally considerable vibration will be communicated to the pillars mounted on this slender bridge of material, and the lamps will therefore be supported by special shock absorbers. Preparations for this work have been in progress for about two years. The lamp standards have been designed for the City Council by Mr. Arthur Davies, F.R.I.B.A. (a recent winner of the prize awarded by the Royal Institute of British Architects for the best building of the year). The new lighting system has been planned for the Westminster Council by the Edison Swan Electric Co. Ltd., working in collaboration with the St. James's and Pall Mall Electric Light Co. Ltd., the former company also supplying the standards and other lighting equipment.



A striking picture showing the G.E.C. Floodlighting of the F.M.S. Municipal Offices at Singapore.